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GEOLOGY.—*Some aspects of the geology, petrology, and mineralogy of Switzerland.*[1]

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The Alps are the youngest mountain range of Europe. Deep valleys, due to river erosion, allow the study of sequences of rocks, their metamorphism and folding within a thickness of some 2,000 to 4,000 meters. In many places a sparse covering of forest, scree, or snow is present; bare rocks can be found everywhere. So by climbing up the cliffs and gullies, by following the contacts of the rocks, and by collecting samples of rocks, fossils, and minerals, Swiss geologists and mineralogists have been able to build up a geological and petrographical synthesis of their country, based on evidence that can be directly investigated in the field.

Taken from north to south, the main zones found in Switzerland are as follows:

(1) The southern part of the *Schwarzwald* (Black Forest), a massif of Hercynian age, not folded in Tertiary times, upon which lies the Jura tableland.

(2) The folded Jura or Jura Mountains proper, resembling a virgation of the Alps and composed of rocks varying from Triassic to Tertiary age.

(3) The Swiss Plateau or Plain consisting of a huge thickness of relatively undisturbed marine and fresh water deposits dating from the Middle Tertiary. This rock assemblage is called "Molasse," a word originally meaning soft sandstone in the local Swiss dialect. Most of this material is derived from the Alps, in which erosion was setting in as folding and uplifting gradually began. Here also we find the more recent glacial deposits. fluvioglacial gravels, and sands of Quaternary age, filling out the deeper part of the broad valleys which traverse the Swiss Plateau.

The southern part of the Molasse region has been affected by the northward push of the Alps. The layers are no longer horizontal but steeply tilted and sometimes folded. The Alpine mountain chain had started to override its own debris.

(4) The fourth important zone in Switzerland is that of the High Calcareous Alps, which include rocks from the Perm or Trias to the Tertiary. These mountains belong to the main chain of the Alps. They show folds, nappes, and clean-cut thrusts of the sedimentary cover. The latter originates from the central massifs and is more or less autochthonous or may derive from the southern parts of these massifs. These sediments are said to be of Helvetic origin. From a general petrographic standpoint we can unite with the Helvetic High Calcareous Alps the so-called Prealps. These constitute an overlying mass of Mesozoic and Tertiary rocks, which in some cases are reduced to isolated outliers (Klippen), remaining in certain synclines of the Helvetic Alps. In other cases they form mountain areas built of material entirely foreign to the district in which they stand. The Prealps are composed of nappes piled up on one another, and there seems to be no doubt that they must be considered as frontal parts of Pennine or east-Alpine nappes that have traveled far to the north in Oligocene and Miocene times.

(5) In the western part of Switzerland, south of the Calcareous Alps, lies a broad

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zone of little-altered old igneous rocks, gneisses, and schists of pre-Triassic age. These are interrupted by zones of metamorphosed post-Triassic sediments. Conspicuous in this zone are the so-called *central massifs*, which bear the names Aarmassif, Gotthardmassif, Mont Blancmassif, and Massif of the Aiguilles Rouges. These massifs are composed of crystalline rocks of Hercynian age and were originally covered by others of post-Hercynian age, ranging from Permian to Tertiary. The Alpine folding pushed up, often as a series of slices, the rigid part of the massifs with the granite nuclei and old schists, while the softer and more pliable sedimentary cover was thrown into the succession of folds and nappes just referred to in connection with the Helvetic High Calcareous Alps. Between the crystalline wedges some of the roots of the Helvetic nappes are still to be found as more or less highly metamorphosed sedimentary synclinal zones.

(6) On the whole, the central massifs with their original sedimentary cover of epicontinental post-Carbonic rocks belong to the foreland of the great alpine geosyncline. To the south of the central massifs, however, we find the so-called Pennine Nappes, formed in the geosyncline itself. The rocks called "schistes lustrées" or "Bündnerschiefer" represent the metamorphosed sediments deposited in this geosyncline. But the older rocks now also form a series of nappes of which the Simplon-Ticino nappes are the lower elements. The Casanna schists of the higher nappes do not belong to the schistes lustrées of Triassic to Tertiary age, but are Paleozoic. Since they originate from similar sedimentary rocks, they often bear a strong resemblance in their metamorphic state to these schistes lustrées.

(7) In the eastern Alps the Pennine Nappes are overridden by the thrusts and nappes of the Austrides or eastern Alps. The lower part of this great overlap is very well developed in the Canton of Grisons, whence the name Grisonides that has been given to these units. The main part of the Austride nappes belongs generally to the southern coast or Hinterland of the main Pennine Syncline. And elements of this tectonic zone are also to be found in the western Alps in the zone of the nappe-roots and in the higher nappes. The Alpine geosyncline had, perhaps, a highly complicated structure and was divided into two main parts. It seems likely that the Austro-Alpine nappes belong to the so-called "Betwixt-mountains" and not to the hinterland of only one syncline. In any case the sediments of the Austrides are different in facies from the Pennine sediments, and there is no question of the foreward drive of these rocks over those of the northern main syncline and the northern foreland.

(8) In the Canton of Ticino and to the south of the steeply tilted zone of nappe roots lies a complex of old and younger rocks in fairly undisturbed position. They are regarded as belonging to the Dinarides and are called in Switzerland the rocks of the "lake district" (lakes of Lugano, Locarno, and Como).

From the standpoint of sedimentary petrography five examples are to be found in Switzerland of sedimentary provinces of the following types:

(1) *The Alpine diluvial-alluvial type of continental sediments.*—This is found in the topographically young region of high mountains and in the elevated features surrounding the Swiss Plateau. It is an association of residual and talus breccia, cave deposits, landslide deposits, cobble and boulder beds deriving from mountain rivers, pebble beds of fluviatile or fluvioglacial character, glacial boulder layers of various types, glacial drifts, grits, sands and silts of fluviatile, lacustrine, glacial, and aeolian derivation, loam of the slopes, muds, marls and clays, and freshwater or lake marls called "Seekreide" (that is, "lake chalk") with layers of peat and schistose lignites. These sediments are more or less unconsolidated and lend themselves readily to the study of mechanical and statistical analysis. Thus the shapes and mineralogical composition can be analyzed and determinations made of the origin and behavior of the material during the different kinds of transport.

(2) The *molassic* or *paralic* type of sedimentation in a continental trough, the last marginal deep of the alpine belt. The matter brought down by rivers and streams from

the alpine ranges which had been folded and uplifted during and after the Oligocene epoch, provides the constituents of the Molasse. The coarser conglomeratic deposits (Nagelfluh) are of the nature of shore or delta sediments, deposited under fresh-water or marine conditions. They play an important role in the topography, forming great cliffs as on the Righi. Sandstones, marls, and clays, sometimes with lignites and fresh-water limestones, are the other important rocks. Two continental periods are separated by a marine transgression and can be correlated with contemporaneous movements of the Alps. Interior compression persisted in the Alps during the Pliocene and led to the overthrust of the Helvetic Nappes over the Molasse. It can be seen from the nature of the pebbles and detritic minerals that the uplift and folding of the Alps began in the south. The first layers of the Molasse contain material from the higher tectonic elements only and were formed before the central massifs were pushed up and denuded of their sediments. At the close of the Pliocene the Alps finally rose up as a huge and lofty mountain range subjected to erosion by glaciers and rivers. Much work has been done on the characterization of the pebbles and heavy minerals, the processes of diagenesis, lithification, etc.

(3) *The true geosyncline (engeosyncline) type of sedimentation*, represented by a comprehensive series of sediments of great thickness and persistent facies, called schistes lustrées, Bündnerschiefer, and the younger Flysch. Interbedded in these sedi-

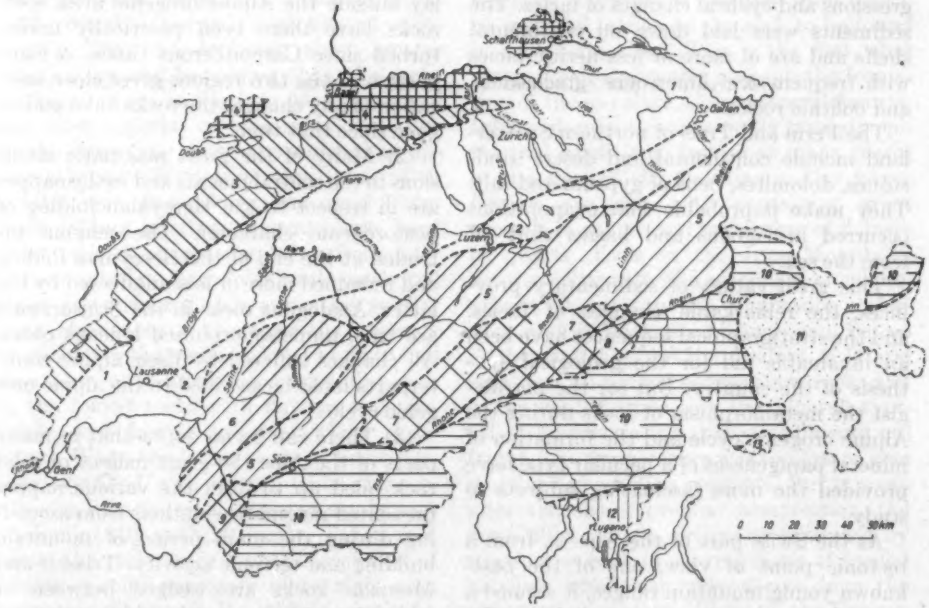

FIG. 1.—Sketch map showing the tectonic zones of Switzerland:
Zone 1: Swiss Plateau (Molasse Region)
Zone 2: Zone of folded Molasse
Zone 3: Jura Mountains
Zone 4: Black Forest-Massif (Hercynian)
Zone 5: High Calcareous Alps
Zone 6: Zone of the Prealps:
Zones 7, 8, 9: Central Massifs (7, Aarmassif; 8, Gotthardmassif; 9, Aiguilles-Rouges Massif)
Zone 10: Zone of the Pennine Nappes
Zone 11: Zone of the East Alpine Nappes
Zone 12: Lake District Mountains (Dinarides)
Zone 13: Tertiary Granite of Val Bregaglia

ments are layers of basic igneous rocks, The whole mass was afterward folded and transformed into calcareous phyllites, and greenstones or ophiolites. The series includes representatives of Triassic, Jurassic, Cretaceous, and in some regions also of Tertiary formations. Radiolarites with manganese ores and greenstones are found in some places, but a typical abyssal or bathyal facies is lacking. During the sedimentation the basin was steadily sinking, but in some zones the folding began to form islands, arches, and geanticlines. The Flysch furnishes ample proof that in the Eocene some folded chains were raised up and subjected to denudation.

(4) The *epicontinental type of sedimentation* is especially to be found in the Calcareous Alps and the Jura Mountains. It is characterized by regressions and transgressions and cyclical changes of facies. The sediments were laid down on continental shelfs and are of more or less neritic facies with frequent reef limestones, greensands, and oolithic rocks.

The Perm and Trias of northern Switzerland include continental and desert sandstones, dolomites, beds of gypsum and salt. They make it probable that evaporations occurred in lagoons and basins shut off from the sea.

This great variety of sedimentary provinces, the remarkable changes of facies, and the stratigraphical sequences have been an invaluable aid for the geological synthesis of the country. But for the petrologist the metamorphism of rocks during the Alpine orogenic cycle and the formation of mineral parageneses of a peculiar type have provided the more fascinating subjects to study.

As the Swiss part of the Alps is, from a tectonic point of view, one of the best-known young mountain ranges, it seemed a promising undertaking to study the relations between the tectonic events and what is called alpine dynamic and dynamic-regional metamorphism (dislocation metamorphism of the Swiss petrologists). It is to be remembered that we find in the Alps rocks of pre- and postcarbonic age and that many of the older rocks were folded in Hercynian time. This period of the Upper Carboniferous was also a time of great magmatic intrusions. All rocks older than Permian have for this reason undergone not only the Mesozoic-Tertiary dislocation, but at least one older dislocation metamorphism as well. In addition to these, an old contact metamorphism has left its traces at many places.

The rocks are, therefore, typically polymetamorphic, and at first sight it seems difficult to establish which of their present features are due to the influence of the young Alpine tectonic movements.

Three groups of observations have in the course of time helped in unraveling of the phenomena:

(1) In the *Schwarzwald* are to be found old rocks quite similar to those occurring in the central massifs and in the cores of many nappes. As the *Schwarzwald* region lay outside the Alpine orogenic area, such rocks have there been practically undisturbed since Carboniferous times. A comparison of the two regions gives clear indication of any changes the rocks have undergone since that time.

(2) Many of the great magmatic intrusions in the central massifs and in the nappes are in respect to the Hercynian folding of postorogenic character. The magma intruded at the end of the Hercynian folding and remained more or less unaffected by the latter. Analogous rocks in the *Schwarzwald* are true, unmetamorphosed igneous rocks. All changes suffered by their alpine counterparts must be ascribed to the alpine orogenic cycle.

(3) There can be no doubt that in many parts of the Alps the great masses of solid rock piled up to form the various nappes prevented magmatic solutions from ascending during the main period of mountain building and tectonic activity. Triassic and Mesozoic rocks are wedged between or folded as a whole into the older rocks and their metamorphism can only be of the pure Alpine dislocation type without any influencing by truly magmatic solutions.

In other parts, especially in the zone of nappe roots, magmatic migration was contemporaneous with some phases of the tectonic movements. There we find Triassic and Mesozoic rocks bearing the signs of

magmatic contact metamorphism combined with dislocation-metamorphism.

These indications will suffice to show that Swiss petrologists have a splendid working field in which to study the metamorphism of rock masses, subjected to external stress forces and when brought under new conditions of load and temperature.

You know that the results arrived at during the petrological exploration of the Alps have brought with them great advances in the science of metamorphism. I need only mention the names of Heim, Duparc, Grubenmann, and Koenigsberger in this connection.

The post-Permian rocks of the superficial nappes of the High Calcareous Alps, the Prealps, and the Eastern Alpine thrusts include dolomites, limestones, marls, clays, sandstones, and siliceous limestones. They have generally not suffered much alteration and resemble normal consolidated sediments. They do, however, show greater lithification and hardening than the rocks of the same age in the Jura Mountains and are often superior as building stones. But at the same time they have suffered an apparently plastic deformation and often exhibit very fine folding and overfolding. Such folding is often unharmonious, hard limestones or sandstones being frequently thrown into few large folds while marls and clays are puckered into numerous smaller ones. Harder strata also show the tendency to glide over the marls and clays and to fold separately or to break into pieces. But even in the folded rocks with flowage textures, joints, and fissures are everywhere to be found. When the latter occur in limestone, they are filled with calcite, while those in siliceous limestones, cherts, and sandstones predominantly contain quartz. Taken as a whole the rocks were during the period of folding a solid aggregate of crystals with increasing diagenesis. To a large extent the plastic behavior of the rocks was not due to the plasticity of the individual crystals. Different parts of each crystal and different crystals suffered different stresses. There was not only a differential movement of the grains, but also a recrystallization promoted by an interstitial liquid solvent, present in all these rocks. The solubility of a crystal is very sensibly increased under the influencing of shearing stress. Material can thus be dissolved where minerals or parts of minerals are under high stress and added to others or other parts, which at a given moment are not subjected to the same shearing stress. That solutions are effective even under these epithermal and not hypabyssal conditions is proved by new crystallizations out of solutions along cracks and fissures and in the pressure shadow of larger crystals or pebbles. Quite commonly open cavities or crevices were formed by tensional stresses in the anticlines and synclines of small folds and were then suddenly filled with crystallizing solutions. This seems to be analogous to the well-known quartz-filled saddle reefs, but the crystallizing material is always of the same nature as the rock minerals. There is no essential transport of material from depth, no material foreign to the rock to be found in such formations. This is the first what we may call embryonic stage in the formation of the so-called Alpine mineral fissures, taking place in this case under strongly epithermal conditions. Indeed at many places in the zone of the Calcareous Alps larger fissures are met with containing great crystals of calcite and sometimes of fluorite or quartz. Even in the Jura Mountains fissures occur with fine specimens of calcite, quartz, fluorite, pyrite, marcasite, celestite, and strontianite. There can be no doubt that they are the product of lateral secretion. In normal sedimentary rocks and in the small fissures only the minerals typical of diagenetically altered sediments are found. The temperature was too low to give more varied reaction products. But in some intercalations of peculiar composition, the same filled fissures, originally produced by stress, now contain a paragenesis of special minerals which can only derive from the surrounding medium. Thus at the Gonzen for example a bedded layer of iron manganese minerals, including hematite, magnetite, ferroan-calcite, hausmannite, rhodochrosite, calcite, and quartz, is intercalated between limestones belonging to the Malm. The Alpine dislocation metamorphism produced folding and fracture with a system of fine joints, cracks, and fissures in the ore

FIG. 2.—Typical alpine mineral fissure. Note the quartsband and the more or less vertical position in respect to the schistosity of the country rock.

deposit and adjoining rocks. In the iron ore the small veins and joints contain:

(1) Quartz, siderite, calcite, sometimes pyrite, or

(2) Stilpnomelane or ripidolite with calcite ± quartz.

In fissures within the manganese-rich part, the minerals are rhodochrosite and calcite, while in the limestone itself the filling of the fissures is restricted to calcite and sometimes a little quartz. Stilpnomelane, ripidolite, siderite and rhodochrosite are in this case the new epithermal vein minerals and correspond in composition to that of the mother rock.

A slightly higher degree of deformation is met with in an east Alpine complex of radiolarites, red shales, and aptychus-limestones with a concordant intercalation of manganese minerals, chiefly braunite. The ferruginous shales and the radiolarite (containing some amounts of sodium) are the rocks directly adjoining the manganese deposit. Within the radiolarites many of the very small fissures are filled with milky quartz; but in the manganese-ore, quartz is accompanied by new and peculiar hydrothermal minerals such as piedmontite, sursassite (a peculiar Mn-zoisite), parsettensite, manganiferous stilpnomelane, tinzenite, a Ca-Mn-silicate with water, sometimes rhodochrosite, magnanocalcite and rhodonite, also occasionally albite. Some of these minerals were first found in the fissures of this locality. As the dislocation and deformation of the rocks took place in several phases, veins of slightly different age can be observed with a normal succession of the minerals quoted. This is due to the fact that the temperature also was changing during the period of deformation.

Some illustrations will give you a good insight into the fissure system and its content of crystals. It must be added that the manganese minerals are only found in the fractured massive ore rock.

Thus we see that the content of the solutions had its origin in the rock itself and that the local formation of such solutions proceeded side by side with the processes of deformation and metamorphism which in this particular case was slight (formation of braunite out of silica- and manganiferous gels and recrystallization of the radiolarian ooze with partial destruction of the organic structure). The filling of and crystallization within the fissures and openings along the lines of fracture took place as temperatures tended to fall as a result of the gradual cessation of the mechanical strains and of increasing denudation by erosion.

This is, as we can prove by many examples, also the history of the formation of the Alpine fissures in the crystalline rocks of the central massifs and the pennine nappes. And it is these which contain the beautifully developed crystals so characteristic of the Alpine region, which have found their way into mineral collections all over the world.

Before giving a short summary of the parageneses of these interesting fissure-deposits (clefts) or "Zerrklüfte," as they are called in Switzerland, we must deal with the alpine metamorphism as manifested by the rocks in the central massifs and pennine region. To what extent the metamorphism assumes different grades according to the position within the system of uplifts and foldings, is best seen by a study of the wedged in or folded in syncliness of younger sediments.

Between the Aar- and Gotthardmassifs occurs a steeply tilted syncline composed of Permian, Triassic, and Jurassic strata. A crystalline thrust-wedge, the Tavetschmassif, divides the eastern part of this syncline into two parts. The southern part is called the zone of Tavetsch or Urseren and can be followed over a distance of more than 90 km along the northern edge of the Gotthardmassif from the Alp Nadels in the Canton of Grisons to the valley of the Rhone. The passes of the Oberalp and Furka as well as the Urseren valley have been carved out of it or the schists of the Tavetschmassif. The sediments are those of the normal cover of the Gotthardmassif with a thick layer of Permain facies called Verrucano, made up of detritus deriving from the Hercynian folding. The Trias is represented by quartzites, dolomites and dolomitic marls, and to the Lias belong sandy, often ferruginous limestones, sandstones, shales, echinodermal breccia, or compact limestones. The same strata, but without the Permian, are present in a sedimentary zone called the Nufenen Piora zone on the south side of the Gotthardmassif. Especially at the east end of the Gotthard pass, in the neighborhood of Lake Piora and Mount Scopi, parts of this zone are intensively folded and squeezed between the rising Gotthardmassif and the partly inverted frontal units of the deepest Pennine nappes. The push exerted by these nappes was very intensive in this region, and the erosion enables us to gain an insight into regions which were originally covered by higher elements of the upper Pennine nappes. There can be no doubt that this southern zone and also the southern parts of the crystalline rocks of the Gotthardmassif were subjected to higher stress and temperatures than were the zone of Tavetsch, Urseren, and the Aarmassif.

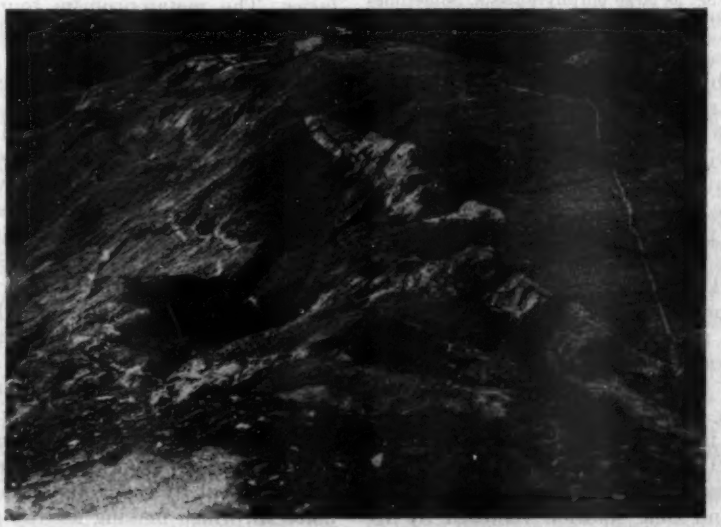

FIG. 3.—Quartsband with mineral fissures which have been opened up and emptied.

The metamorphic derivatives of the Triassic and Liassic sediments with remnants of fossils are as follows:

Northern zone:

Dolomite: sometimes converted to marble, sometimes crushed.

Dolomite marls: metamorphosed to chloritoid schist with chloritoid porphyroblasts and a groundmass of quartz, sericite, chlorite, hematite.

Calcareous sandstones and argillaceous sandstones: metamorphosed to so-called cipolin, a sericite quartzite with or without carbonate.

Clays: converted to phyllite.

Limestones: slight formation of marble and some crushing.

Southern zone with higher grade of metamorphism:

Dolomites: mainly converted to marble, sometimes squeezed out into lenses. Newly formed minerals include grammatite, actinolite and in some places phlogopite.

Dolomite marls: metamorphosed to mica-schists with biotite, hornblende and often garnet as porphyroblasts with often a little sodic plagioclase. In some zones it can be observed that chlorite and biotite were formed together while in a transitional zone sericite-albite-chlorite schists occur.

Calcareous marls and limestones: newly formed minerals are zoisite, epidote, garnet.

Sandstones furnish mica quartzites.

Clays: are transformed into beautiful mica-schists with biotite or cyanite and staurolite or garnet as large porphyroblasts. Sometimes hematite is replaced by magnetite.

All these schists have a freely developed crystalloblastic, porphyroblastic, or poicilo-blastic structure with crystal growth under stress. As a result of differential movement the growing porphyroblasts often show a marked rotation with S-shaped inclusions. The same is true of the chloritoid porphyroblasts in the chloritoid schists of the northern zone. Indeed, the movement of the chloritoid porphyroblasts in respect to the fine-grained ground mass may be so pronounced as to lead to the formation of crevices on both sides of the porphyroblast crystals. Such spaces became filled with solutions out of which crystallized unstrained individuals of quartz, chlorite, or sericite. This is another proof that already in the stage of metamorphism solvents were active and that solution followed by renewed crystallization was proceeding on a considerable scale.

In the southern zone the metamorphosed sediments are often of a coarse-grained nature and show no relicts of the original textures. Typical isometric porphyroblasts such as garnet may have diameters of 1 to 3 cm, whereas the length of cyanite, staurolite, or hornblende crystals may attain several centimeters in length. But in some of the folded and twisted rocks irregular open spaces are frequently found. They were filled with solutions from which quartz, idiomorphic cyanite, staurolite, and garnet free from inclusions have crystallized. So here again there can be no doubt that solvents were active during the period of metamorphism. Nevertheless, the succession of different metamorphic rocks, even when extreme folding has occurred, accurately reflects the original sedimentary sequence with very sharp boundaries between the original layers. No signs of long distance diffusions or metasomatism with solutions coming from below are to be found, and all observations point to recrystallizations from locally formed solutions during a long period of deformation.

Swiss petrologists call metamorphism of the type found in the northern zone of the Gotthardmassif *epimetamorphis*. The rocks there constitute an epithermal metamorphic facies. The metamorphism found on the southern border of the Massif and especially in the Lukamnier-Piora region, is termed *mesometamorphism*, and produces a mesothermal metamorphic facies. A study of the pre-Permain rocks in the Massif itself and of the rocks of the deepest Pennine nappes shows that the tectonic events there are correspondingly more intense. Judged from the same point of view it is to be expected that the metamorphism of the higher and more superficial Austride nappes will be of epizonal character, while in the Pennine roots katametamorphism is likely to prevail. For here intrusions of magma (basic at first, acidic later on) took place during the folding and invaded areas in which a slackening of pressure made itself felt. The reason for the latter was the squeezing out by the compressing forces of material, which making its way northward went to build the nappes.

It is not possible in this paper to discuss

in detail the correctness of these deductions. We must limit ourselves to an examination of the metamorphism exhibited by the old crystalline units of the central massifs, these being important as containing the chief localities at which fissure-minerals are found.

The older rocks of these massifs are as follows:

(1) Great complexes of diorites, granodiorites, granites and quartz-porphyries of the post-Hercynian epoch were found in upper carboniferous times. In the Aarmassif they are accompanied by syenites and monzonites with an intrusion of related magmas of rather greater age. Pegmatites, aplites and lamprophyres as well as porphyritic rocks are plentiful.

(2) The Hercynian magma was intruded into old paragneisses and mica schists with basic intrusions of amphibolitic or peridotitic character.

(3) A series of old orthogneisses with local occurrences of old hornfelses, conglomeratic gneisses, eclogites, and rarely of Paleozoic limestones.

Apophyses of the old orthogneisses and of the younger intrusive rocks have penetrated, digested and metamorphosed the schists. At some places fine examples of an old magmatization are visible and old injection gneisses are frequent.

(4) The permocarboniferous is often concordantly enwrapped and consists of sericite and muscovite gneisses and schists, conglomeratic gneisses, psammitic to pelitic gneisses with intercalations of permocarboniferous quartz porphyries, spilites and diabases.

The rigid masses of the Hercynian intrusive rocks and a great part of the old gneisses were not folded by the Alpine tectonic movements, which merely compressed these old Hercynian massifs.

The push of the Pennine nappes from the Alpine geosyncline was naturally stronger in the more southern massifs of the Mont Blanc and Gotthard than in those of the Aiguilles Rouges and Aar farther to the north.

The old massifs were uplifted and developed a more or less vertical schistosity. However as the push made itself most felt at the base, a fan-shaped structure has been produced at many places.

Phenomena of destructive metamorphism in the epizone are very widespread and include the formation slices, zones of mylonitic or crushed rocks, etc., features which are very conspicuous in the present morphology.

Every massif has one or two transversal anticlines, that is, culminations in the uplift, whose axes sink down on each side, producing a domelike shape. The greatest culminations are situated on a line running from north to south, from the valley of the Reuss to the valley of the Ticino and the Simplon-Ticino culmination. To the south of these massif culminations the deepest nappes outcrop in the depressions, while on each side the highest nappes are exposed at the surface and the deeper ones remain invisible in depth.

But the schists of the massifs have, as a result of the compression, everywhere been brought into a more or less vertical position. Only at the east end of the Gotthardmassif could the Pennine and Austrian nappes in the course of their northward movement thrust the sinking massif over the rocks of the Aarmassif.

In the main part of the Gotthardmassif the metamorphism of the old rocks often exhibits the following typical features: In rocks of massive texture quartz has suffered internal fracturing and possesses a cataclastic structure with some signs of recrystallization. Along the planes of strong differential movements the relicts of larger quartz crystals have assumed a lenticular or eye shape (augen) with mortar-structure in a finely crushed and sometimes recrystallized ground mass. In the mylonites the intensive crushing is combined with a schistose texture. But everywhere the destructive processes are followed by constructive ones, comprising not only recrystallization of the original constituents such as quartz, but also chemical reactions giving rise to new minerals. Sericite or muscovite is formed from alkali-rich feldspar, zoisite, and epidote from plagioclase, the mixture of these minerals with newly formed albite constituting what is called saussurite. Chlorite develops at the expense of biotite,

serpentine and talc from olivine and orthopyroxene, actinolite from augites and the more complex hornblendes etc. Many minerals of complex composition suffer unmixing accompanied by the formulation of iron-ore minerals, rutile, etc. Analogous mineral changes accompany the metamorphism of already metamorphic rocks and, as we have seen, the newly formed minerals in the younger sediments exhibit the same epimetamorphic character.

In the southern part of the Gotthard-massif in the so-called "Tremola-schists" and also in the deepest Pennine nappes a complete recrystallization of old and young rocks has taken place under mesozonal conditions. Granites have been transformed into two-mica gneisses. And in the zone of the nappe-roots where pegmatites strike across the schists, contact metamorphism of katazonal character is combined with the dislocation metamorphism.

One effect of the strain of the great tectonic movements, especially in the regions of the greatest uplifts, was the formation of torsion cracks and fissures. These developed in directions more or less perpendicular to the foliation or schistosity of the rocks and consequently lie horizontally in the central massifs and nearly vertically in the nappe-regions. Larger fissures resulted in massive rocks under relatively small loads than in finely foliated paragneisses or paraschists or in the region of the deepest nappes. Relatively large dimensions were attained by the fissures especially in the slightly epimetamorphic granites of the central massifs. Here open cavities of the size of caves were sometimes formed. The solutions circulating in the pores of the metamorphosed rocks filled the crevices and effected a very marked decomposition of the surrounding rocks. It thus often happens that the crevices are surrounded by narrow zones of altered or leached rocks. As the tectonic stresses gradually diminished and increasing erosion resulted in a reduction both in load and temperature, conditions were attained under which crystallization could take place out of these solutions or from others of low temperature which had joined them. The resulting crystals were able freely to develop into the spaces occupied by the solutions and thus to attain the size and perfection often characteristic of the alpine specimens. In many cases the leached zone became impregnated with newly formed crystals. This had the effect of sealing off the cavities and the contained solutions from their surroundings. Koenigsberger was the first to prove that the newly formed minerals found in the fissures are derived chiefly from the surrounding rocks. Lateral secretion during the period of tectonic deformations followed by crystallization from the cooling solutions are the factors leading to their formation. According to his estimates crystallization may have started at temperatures of about 350° and proceeded at intervals down to temperatures of 100° or lower. Many investigations (some not yet published) by students of the Federal School of Technology at Zürich have confirmed his results and furnished many additional details about the processes involved.

The best description and systematic arrangement of the various mineral paragenes found in the alpine fissures were given in the book published in 1940, *Die Mineralien der Schweizeralpen*, by my friend and collaborator Prof. R. L. Parker, who is also keeper of the well-known collection of Swiss minerals at the Swiss Federal Institute of Technology in Zürich. He divides the Swiss section of the Alps into twelve characteristic areas as follows:

1. Maderanertal
2. Guttannen-Goppenstein
3. Fellital-Giuf
4. Göscheneralp and Grimsel
5. Oberwallis and Urserental
6. Tavetsch and Vorderrheintal
7. Gotthardpass and Greina
8. Adula
9. Southern and easterly Grisons
10. Ticino
11. Binnental-Simplon
12. Zermatt

In each region he distinguishes a number of groups of localities comprising occurrences belonging to the same mother rock and of similar paragenesis. The connection that is thus brought out between mother-rock and mineral assemblages, is a typical feature of the Alpine-type localities and one that is only to be expected if Koenigsberger's

theory of lateral secretion is correct. Of the 58 groups described in the book only a few can be selected for mention here as illustrating the occurrence of typical Alpine minerals.

In the Maderanertal area, which is situated in the northern zone of schists in the Aarmassif, fissures in the paraschists show the following paragenesis of minerals: Quartz, adularia, albite, calcite, brookite, anatase, rutile, apatite, ilmenite, pyrite, sphene, and monazite. Of the TiO_2 minerals brookite is certainly the most conspicuous and these localities, which include the famous Grieserntal, furnish the best Swiss specimens today. Anatase is also frequent and the two minerals frequently show the phenomenon known as differentiation in the fissures. That is to say they either occur on different walls of the same fissure, or else appear separately in adjoining fissures. Cases are, however, frequent in which both minerals occur in close association, and are even joined by the third TiO_2 mineral, rutile. This is a quite anomalous state of affairs as according to physical chemical theory only one of these phases can be stable. Investigations in the laboratory has proved rutile to be the actually stable phase, and this is borne out by the observation that both brookite and anatase may be wholly or partially changed into aggregates of fine acicular crystals of rutile. Of the other minerals quartz may be mentioned as very frequently showing ghosts or phantoms as many as seven or eight being sometimes visible within a single crystal.

The importance of the TiO_2 minerals in the fissures of para-rocks is confirmed by the reappearance of similar parageneses in other areas. Thus in the now largely exhausted fissures of the Adula (area of Vals Platz) magnificent brookites 3 to 4 cm in length were found. Here also anatase occurred, and rutile often contained as needles in the quartz crystals has been found in superb specimens of rutilated quartz. In the Tavetsch valley, again, a similar paragenesis is found in para schists, though in this case anatase and rutile are generally far more important than brookite. The same is true of the fissures in the para-rocks of the famous Alpe Lercheltini near the village of Binn in the Valais. Here the conditions for the crystallization of anatase must have been ideal ones, for crystals of a size and richness in form development are found, which surpass anything found at other Swiss localities.

It is thus seen that while a given paragenesis may repeat itself at several or even many widely separated localities, each one of these exhibits its own local particularities as regards the mineral selection, form and habit development.

Returning to the Maderanertal, we find intercalated between the schists amphibolites deriving from basic igneous rocks. The assemblage carried by the fissures in these rocks is totally different from that just mentioned and can be given as follows: Calcite, adularia, quartz, albite, chlorite, amiant,[2] sphene, epidote, apatite, prehnite, pyrite. Especially the appearance of amiant, sphene, and epidote accurately reflects the change in chemical composition of the mother rock and gives rise to crystallizations as interesting in their way as the ones just described. In many of the valleys and ravines at the west end of the Maderanertal quite unusually rich crystallizations of amiant occur. The mineral is often of almost hairlike habit and may occur in loose heaps or in a more or less fluffy or felted state of aggregation, often resembling animal fur. On the other hand, it may also assume a more leathery consistence. At some localities in the west, but especially to the east of the Maderanertal at the Alp Cavrein, epidote is found in large crystals rich in faces and the same is true for crystal lizations found in the frame work of this paragenesis in other areas, for instance at the Kammegg near Guttannen. But quite the most famous instance of this type of epidote occurrence lies in the Tyrolese Alps in the eastern Alps. The Knappenwald locality in the Untersulzbachtal produced what were certainly Europes finest epidotes in exactly the association given above and formed under just the conditions and in a similar mother rock as at the Swiss localities.

[2] An exceedingly fine silky variety of asbestos.

Sphene is a very notable constituent of fissures of this type in some areas, three well-known examples being the Drun Tobel just north of Sedrun in the Tavetsch valley, the Motta Nera in the val Nalps and the Alpe della Sella. The first and last named of these places have been famous for large sphene crystals, in fine V-shaped twins, for many years. They are often of yellow color, passing abruptly to green at the ends where the binary axis passes through the crystal. The Motta Nera area is a comparatively recent discovery which has supplied not only excellent dark brown sphene but also prehnite in profusion and sometimes very large crusty specimens. An interesting feature of the calcite found in this paragenesis is the fact that the early crystallizations are tabular in habit, while at later stages the chief rhombohedron tends to develop strongly. Thus calcite plates are sometimes found covered by rhombohedral elevations.

Rather similar to the amphibolite paragenesis is that carried by the fissures in the so-called potash-syenite of the Piz Giuf area. The following list of minerals shows, however, that the zeolite minerals are often much more plentifully represented than in the last case where they are of more incidental occurrence. The mineral assemblage for syenite fissures is as follows: quartz, adularia, calcite, chlorite, desmine, scolecite, stilbite, apophyllite, laumontite, chabazite, amiant, apatite, sphene, epidote, milarite, etc.

Amiant is one of the first minerals to crystallize and in these fissures is often shorter and stiffer in form that in the occurrences mentioned just now. A point of genetic interest is the very intimate relationship between this fissure mineral and the hornblende in the rock which sometimes shows signs of recrystallization on the fissure walls with transitions into amiant fibers. At the other end of the sequence of crystallization lie the zeolites which are among the last minerals to separate. In rich associations comprising all the species just mentioned, they form crusts covering the other minerals and especially the quartz crystals, following every detail of their contour. It is as though a semiplastic mass had been molded around the earlier formed minerals. An interesting specimen in the Zürich collection is a fairly large quartz crystal which, having attained a certain weight, broke off from the wall of the fissure at the bottom of which it was found. The fractured surface has become covered by aggregates of desmine which proves that the break occurred while crystallization was still in progress. It is in fissures of all types a common occurrence for quartz to break off and then regenerate the fractured surface, producing finally crystals without any apparent center of growth.

In the syenite fissures the quartz crystals are colorless to dark brown or even black, the latter being called *morion*. These varieties appear at quite different localities, the general rule being that the darkest colored crystals come from the highest points and usually from such at least 3,000 m above sea level. This peculiar fact is explained by Koenigsberger as follows: The dark coloration is produced by the radioactive influence of certain constituents in the mother rock. In order for these to be effective, low temperatures are required which is, of course, the case at the highest localities. Strict comparisons on these lines are only possible when, as in the Giuf area, higher and lower localities within the same mother rock are available. Many of the quartzes from here are beautifully developed with several broad trapezohedron forms beside the S-faces. They nearly always show signs of Dauphiné twinning, the combination of two right crystals being, as several statistical counts have shown, of the same frequency as the left+left combination. It must, however, be added that extensive research, carried out on quartzes from these and other Swiss localities, have shown the individuals to possess a very much more complicated system of twinning (including the brazil law) than can be inferred from the face development alone. The Giuf localities are one of the main sources of what Swiss collectors call "Gwindel," that is, twisted quartz crystals. These, as is well known, consist of a series of individuals each slightly rotated in position against their neighbors. The degree to which these various crystals are intergrown varies very much from specimen to specimen.

Some show very clearly where each individual ends and the next one begins and are called "open" specimens. "Closed" specimens are those in which the intergrowth is so complete that all individual points have disappeared and have been substituted by one long curved edge.

In some fissures from marginal areas of the syenite the quartz crystals often contain long hollow cavities of rectangular cross section. It has been shown that they originally contained anhydrite which has, however, been redissolved, leaving the hollow shape of its crystal form. This redissolution took place fairly early as zeolite minerals have often been deposited within these "air pipes" as we call them.

Let us finish this brief survey of the Val Giuf minerals with a mention of the interesting mineral milarite, so-named by one of my predecessors in Zürich after the Val Milar. Unfortunately the mineral does not occur at the locality after which it is named, Professor Kenngott having been the victim of a deception on the part of the original finder. The actual locality, as is now known, was the Giuf glacier, and a pupil of mine, Mr. Huber, has recently found new occurrences with some exceptionally large crystals. Milarite was originally considered to be a potassium-calcium-aluminium-silicate, but Prof. Charles Palache in 1931 showed that it contains beryllium in addition to these elements.

Of the greatest importance for their mineral fissures are the great granite areas of the Aar and Gotthard massifs. In the Aarmassif the granite forms one connected mass, stretching from the Grimsel area in the west to beyond the Reuss valley in the east. The fissures throughout this broad expanse of mountains all bear much the same paragenesis consisting of: Quartz, calcite, chlorite, fluorite, apatite, hematite, pyrite. Adularia and albite are not plentiful in these fissures, which in this respect form a contrast to most others. Accessory minerals are zeolites, epidote, sphene, TiO_2-minerals, and, rather strangely, galena, a clump or two of which is often found with the ordinary minerals.

The fissures in this area are often of quite exceptional size and have sometimes attained the dimensions of caves in the rock. This was the case at the famous locality found in 1866 at the Tiefenglacier and again at a spot quite recently discovered in the same neighborhood. It must not be thought however that on entering such a cavern the discoverers found the walls covered by beautiful crystals. Quite the reverse was the case. For in the available free space the quartzes had grown to a size and weight

FIG. 4.—Exploitation of the large mineral fissure on the Tiefenglacier in August 1866 (contemporary etching).

which caused them to break off from the walls and fall on to the floors of the cavities. However, as there had previously been copious crystallizations of sandy chlorite material, they feel on to a soft yielding mass and so remained imbedded in this material and quite undamaged. Crystals from the old Tiefenglacier locality attained a length of 2½ to 3 feet and in some cases a weight of 250 to 260 pounds.

These very large fissures are remarkable also for their very broad quartzbands. These consist of granular or massive quartz which forms as an early crystallization at the tapering ends and around the fissure-

cavities proper. Most fissures possess more or less quartzband and are frequently discovered by the appearance of this massive quartz on the rock surface. But in these cases the bands attained unusual dimensions, sometimes as much as 7 feet. The exploitation of this fissure assumed the proportions of a small mining operation, regular adits being driven into the rock. That was late in the seventeenth century, a time when the collectors were only interested in the rock crystal. What is really the most beautiful mineral of this paragenesis, the fluorite, they threw aside and it has remained for collectors of later generations to appreciate and study this mineral. It possesses a very remarkable rose red or pink color quite unlike the fluorite found elsewhere. Many crystals are uniform in color, but in a beautiful lot of specimens in the Zürich collection the cores of the crystals are pink and the surrounding layers quite colorless. The commonest form is the octahedron, though the bicolored crystals just mentioned show the cube also, and others a trace of the rhombic dodecahedron. It was long believed that the Aarmassif alone possessed these pink fluorites, but material of similar color has been found in pennine series of the Adula, and in an occurrence in the Gotthardmassif (Nalps glacier) which aroused much interest in 1938.

The granite of the Gotthardmassif is (in contrast to the Aarmassif) not one connected mass, but divided into several separate units of rather different mineralogical and structural composition. To the mineralogist one of the most interesting varieties is the Fibbia granite, a rather porphyritic rock, building the mountains surrounding the Hostel on the Gotthard pass. It contains many fissures whose characteristic paragenesis is as follows:

Adularia, quartz, albite, muscovite, chlorite, hematite *or* apatite (these minerals very seldom occur together), and accessories such as zeolites, pyrite, some TiO_2-minerals, etc. The term adularia as we understand it generally applies to a colorless transparent potash feldspar with rather pronounced pearly luster and a typical crystal habit dominated by (110)(101) and small to medium faces of the basal plane (001). The general aspect is sometimes rather pseudorhombohedral in character. But many occurrences of adularia show that these features do not always appear together. Thus many fissures contain milky white crystals of only translucent or even nontransparent character. On the other hand, the fissures of the Gotthard granites show that typically transparent adularia may assume the elongated prismatic habit of the Baveno type. The fine crystals found in this area are very often complex twins, consisting of four individuals of which adjacent ones are twinned on the Baveno law while opposite ones show twinning after Manebach. The appearance of muscovite in the paragenesis is a characteristic feature not found in the more northerly Aarmassif. But undoubtedly the main interest of these occurrences concentrates on the minerals hematite and apatite which are found in specimens of outstanding quality.

The hematite of the Gotthard pass is of pronouncedly tabular habit and on the whole not very rich in faces. It shows the tendency to form subparallel aggregates much resembling the arrangement of petals in a filled rose bloom, and this comparison has caught the imagination of the collectors, who have long since chosen the name of iron roses for these groupings.

Very notable specimens have come from these fissures, some of the finest being as big as a fist and showing brilliant metallic luster. Comparisons could be made between these hematite crystals and the crystallographically very much more complex specimens occurring at the Alp Cavradi south of Tschamutt in the Tavetsch valley, but this would take more time than we can spare now.

Turning to the apatite crystals, we can only suppose that the conditions for the formation of this mineral were quite ideal ones, for in some fissures it occurs in very numerous individuals, of sometimes large size and always very complex development. It is no rare thing to find 50 or 60 perfectly reflecting faces on one small crystal which may be tabular, short or long, prismatic or occasionally bipyramidal in habit. The crystals are colorless or sometimes of a pale violet color which, however, like the

violet of the rare Swiss amethyst, fades in sunlight. Some recently found large crystals are practically opaque and milky white.

In a granite area farther east called the Cristalina granite, a paragenesis of other character is found in rather plentiful occurrences. It contains the following minerals: Adularia, albite, quartz, chlorite, calcite, muscovite, axinite, apatite, epidote, sphene. It is the axinite which distinguishes these localities and often appears in excellent large-sized crystals. Many of them are chlorite covered and then gray green in color and without luster; but on specimens free of chlorite the crystals are of a brilliant purplish to reddish-violet color, and in every respect equal to the famous ones from Bourg d'Oisans in the French (Dauphiné) Alps. The appearance of this boron-silicate in some quantity is interesting and not easy to explain satisfactorily out of the mineral and chemical composition of the mother rock.

To the south of these granites follows the zone of the so-called Tremola schists, which have many fissures with the following mineral assemblage: Albite, quartz, calcite, siderite, ripidolite, rutile, tremolite or amiant, tourmaline, pyrite, etc. A remarkable feature of the specimens from these localities is the morphological development of the quartz crystals which contrast sharply with those found in all the more northerly occurrences. The faces of the prisms and of the unit rhombohedra are often reduced to fairly small dimensions, while those of numerous acute rhombohedra dominate the habit. This gives the crystals a peculiar tapering aspect, which is quite typical for the zone in question, but is also found in the Pennine areas of the Ticino. The habit has therefore been called the Ticino-habit and constitutes a classical example of how the development of a crystal habit depends upon the surroundings and circumstances under which it is formed. These quartzes are of quite unusual limpidity in spite of the fact that they are often full of inclusions, these latter consisting chiefly of chlorite, tremolite and tourmaline.

Passing to the fissures of the Pennine nappes, we can only briefly mention the famous locality of Campo Lungo, where the white saccharoid dolomite marble contains many fissures with grey grammatite, bright green tourmaline, reddish or bluish crystals of corundum, diaspore and beautifully developed and twinned crystals of dolomite. Near here a unique paragenesis was found in fissures of a calcareous phyllite. It contained scapolite crystals of gem quality which are quite unlike any other alpine occurrence of this mineral.

A few words must be devoted to the contents of the fissures found during the construction of the Simplon tunnel. The paragenesis included very rich crystallizations of calcite, dolomite, and siderite beside beautiful violet crystals of anhydrite. Quartz, adularia, albite, chlorite, rutile, muscovite, and the rare hamlinite (Al-Sr-phosphate) were other minerals. Both in composition and aspect these crystallizations are markedly different from the mineral assemblages found in more superficial fissures. It is worth remarking, however, that in other tunnels such as the Gotthard and also in some underground workings as for instance at Monte Piottino, rather similar formations have been met with. This raises the question whether with increasing depth the character of the fissure fillings undergoes a certain change and whether these "tunnel parageneses" as we sometimes call them, are indicative of the type of mineral formation prevalent in lower levels than those usually accessible.

FIG. 5.—Iron rose (Binnental area). Typical subparallel aggregate of tabular hematite crystals.

The most famous locality in the Pennine area west of the Ticino is, of course, the Binnental. Reference has already been made to the superb anatase crystals from here and I shall presently return to the unique mineral assemblage found in the white saccharoid dolomite rock at Lengenbach.

Let us now conclude this very rapid survey of the Alpine fissure deposits with a brief glance at the famous minerals from the Zermatt area. These are contained in fissures of basic rocks (metamorphosed gabbros, peridotites, etc.) and also in rocks produced by contact metamorphism of the basic igneous rocks on limestones. Garnets, both red and green, the latter sometimes in large nodular masses, idocrase in lustrous beautifully developed green or brown crystals, epidote and large well-developed pseudorhombohedral crystals of pennine are among the minerals more commonly met with. Perovskite is rarer but also of fairly frequent occurrence, sometimes in honey yellow or orange colored nodular masses, sometimes in well formed reddish brown cubes. Another mineral sometimes met with is lasulite in sky blue masses, which can be cut and polished to make attractive gem stones.

It is in general true to say that all the important chemical elements found in the rocks are also represented in the fissure minerals. In what particular mineral or minerals each element is contained, can best be seen from Table 1. Under epi to meso conditions the metamorphic processes run more or less concurrently with the formation of the crystals in the fissures.

The general succession of order of crystallization of the fissure minerals is given in Table 2.

The observed facts can be summarized as follows: The crystallizations often begin with the formation of alkali feldspar or epidote or amiant. In later stages water-rich minerals such as muscovite and the zeolites are formed beside oxides such as hematite, rutile, etc. From the residual solutions which have become poor in alkalis and rich in Mg and carbonate ions, chlorite and the carbonates are the chief minerals to crystallize. Quartz is in the fissures of silica-rich rocks, an "ubiquitous" mineral, that is to say one that can appear in practically all parageneses and at all periods of the crystallization. In especially quartz-rich rocks, quartz is without doubt the dominant fissure-mineral. Fluid and gaseous inclusions in which the bubbles disappear on heating, sometimes enable estimates to be made of the temperatures and pressures prevailing at the time of crystallization.

The fissure minerals of the Alpine type are scarcely found elsewhere in the same parageneses and development. Even in the

TABLE 1. CHIEF PROCESSES LEADING TO THE FORMATION OF FISSURE MINERALS

Original minerals	Processes	Crystallization of:
Plagioclase	Decomposition of the calcian feldspar molecules; solution	Epidote, prehnite, calcian zeolites, albite, carbonates, quartz
Alkali-feldspars	Unmixing and partial solution	Potassian feldspar (adularia) and sodian feldspar (albite), rarely of alkali-zeolites
Biotite	Separation of TiO_2 and Fe-oxides; release of potash	Chlorite, hematite, limonite, Ti-oxides, beside adularia and quartz; sometimes formation of Fe- and Mg-carbonates
Augites and hornblendes	Loss of Al, Ti, Ca, often Fe-decomposition and solution	Epidote, hornblende asbestos, calcian zeolites, calcite, dolomite, Fe- and Ti-oxides, or titanite, quartz
Olivine	Hydrolysis, loss of Fe oxidation	Serpentine or talc and magnesite together with Fe-oxides
Quartz	Partial solution	Renewed crystallization of quartz
Carbonates	Partial solution	Renewed crystallization of carbonates

TABLE 2. SEQUENCE OF CRYSTALLIZATION OF MINERALS IN FISSURES OF GNEISSES AND MICA-SCHISTS

Water-free or water-poor silicates	*Early stages of crystallization:* Amphibole-asbestos, epidote, adularia, usually also quartz.		
	First succession: Albite, tourmaline, apatite, rutile, anatase, sometimes hematite, anhydrite.	Continued crystallization of adularia and epidote	Continued crystallization of quartz
Water-rich silicates, oxides, carbonates	*Second succession:* Muscovite, titanite, hematite, brookite, fluorite, chlorite, carbonates.	Continued crystallization of some minerals of the first succession	
	Final crystallization: Calcite, chlorite, prehnite, zeolites.		

Alps conditions favorable for their formations were not everywhere present. They are found especially in the following regions: The central massifs from Pelvoux, Grandes Rousses, Belledone in the Dauphiné to the Mont Blanc-, the Gotthard- and Aar-massifs, the Pennine nappes from the Simplon to the Adula and the great culminations of the Zillertal alps, Grossvenediger and Sonnblick-Hochalm in the eastern Alps. All these regions are transversal culminations or anticlines of the Alpine arc. In the neighborhood of these great anticlines (and not in the tectonic depressions) conditions were favorable for the formation of open fissures during the uplift. This in turn was a necessary condition for the circulation of the solutions which having gathered their material, were able to deposit it in the open spaces and give rise to the mineral specimens we now admire.

As the chief rocks of the Alps are of normal chemical composition, the common fissure minerals themselves are of quite usual composition also. But where rocks of special character and chemical composition were concerned, the peculiar genesis of the fissure minerals finds its expression in the appearance of rare mineral species.

This has already been pointed out in connection with the manganese ore deposits and further confirmation is furnished by the classic mineral locality of Binn in the Canton of Valais. With the Triassic dolomite rock, found there, is incorporated a sulphide layer containing as primary minerals pyrite, a little argentiferous galena and blende, chalcopyrite, and arsenopyrite. During the Alpine metamorphism the dolomite was converted into a saccharoidal marble while in small cavities new minerals of the sulpho-salt-type were formed which are for the most part exceedingly rare species. They include lengenbachite, rathite, hutchinsonite, seligmanite, baumhauerite, dufrenoysite, jordanite, and sartorite, most of which were first described from this locality and some of which have never been found elsewhere. Tennantite, realgar, orpiment, proustite, barite, hyalophane, and dolomite are other minerals occurring in these fissures.

Such special paragenes allow a comparison to be made with those of the ore deposits, as given for instance in Lindgren's classification. Judged by their mineral content and temperature of crystallization the alpine fissures may be called an autochthonous hydrothermal type of deposit of meso- to epithermal character. They are related to ore deposits formed near the surface and also to the deposits of native copper and zeolites in the Lake Superior region. What is essential is the recognition of the fact that the fissure minerals were formed in a more or less closed system during the dislocation and metamorphism of the rocks without the participation of substances contained in solution by ascending waters or liquors.

Let us recapitulate:

After the chief system of nappes had

already developed in the Alps, a very pronounced longitudinal corrugation came into being during the last phase of the compression of the Alpine chain. As a result of the obstruction offered by the crustal masses in the foreland great culminations and depressions gradually took shape while the flat mountain land was erected into a system of high mountains. Erosion set in and became increasingly active, though it could not keep pace with the uplift or carry away what the folding had built up. In the culmination zones and particularly on the flanks of the chief uplifts fissures were formed and quickly filled with aqueous solutions. These thermal waters had become charged with substances previously dissolved from the surrounding rocks. Crystallization from these solutions set in as the effects of gradually diminishing pressure and temperature made themselves felt. In the course of long crystallization processes crystals of unusual perfection were formed which today are the ornaments of the high Alps. The composition and associations of these minerals give indications as to the temperatures which must have prevailed in the mountain area at the time of their formation. Crystal species which at an earlier period had been formed in the rocks are found to have become unstable and to have undergone unmixing and decomposition, thus giving rise to other minerals. The search for and collection of these crystals not only provide aesthetic pleasure but also furnish much valuable information about the formation of the Alps themselves, of the mountain range, which is the backbone of Switzerland.

BIOLOGY.—*The principle of priority in biological nomenclature.*[1] RICHARD E. BLACKWELDER, U. S. National Museum.

An article under this title by Dr. A. C. Smith of the Arnold Arboretum appeared in Chronica Botanica **9**: 114–119. 1945. It consists largely of a critical review of a paper from the zoological viewpoint by Franz Heikertinger, published in 1942 in Germany[2] which is "an undisguised attack on the principle of priority"[3]

Both Dr. Heikertinger's proposal of a principle of continuity and Dr. Smith's critique are of interest to taxonomists in zoology as well as in botany. The present remarks are intended to expand Dr. Smith's review and to carry on the arguments against Heikertinger's proposal.

The goal which Dr. Heikertinger hopes to attain with his new proposal is very attractive. It is that *within 30 years every species of animal will have one single universal name in use.* This is the millennium in nomenclature, the goal of complete stability which has seemed so far away to most taxonomists. This goal is to be attained by discarding the principle of priority and substituting for it the so-called principle of continuity, that "the valid name of a genus or species is the one which the monographer finds in scientific usage, regardless of whether or not this is the earliest name."

This statement of principle immediately raises several questions which must be satisfactorily answered before the principle could be applied in actual practice. (1) Who is to be accorded the status of monographer with authority so much above the ordinary taxonomist? (2) If monographers disagree, which is to be accepted? (3) How can biological considerations be kept separate from nomenclatural ones, or, as Dr. Smith implies, are biological facts to fall at the monographer's whim along with the nomenclatural ones? (4) What will happen when the monographer bases his work on totally inadequate bibliographic or taxonomic research and makes an obvious and demonstrable error? (5) Would complete stability be reached even with the elimination of purely nomenclatural changes?

(1) Apparently the question of who is a monographer is not discussed by Heiker-

[1] Received May 14, 1948.

[2] HEIKERTINGER, FRANZ. *Das Nomenklaturproblem der Gegenwart. Zugleich ein Aufruf an alle Biologen.* Der Biologe, 1942: pp. 20–27.

[3] Direct quotations are from Dr. Smith's paper.

tinger. There is an implication that the monographer is someone special, readily distinguished from other workers. One group of "monographs" is mentioned that may give us a clue. Heikertinger states that zoological nomenclature was more or less established about 1850, because of the thorough monographs of that period. Since Heikertinger is an entomologist, these monographs were probably the large regional works such as the Naturgeschichte der Insecten Deutschlands, and the numerous large works of Erichson, Kraatz, Redtenbacher, Mulsant, and others.

These works were of restricted geographical scope, being in fact not true monographs at all but revisions of the species of one region. They doubtless helped to fix names in use locally for a few years, but their influence in the long run depended upon their accuracy in a broad sense. Stable nomenclature can not be based upon the names in use in one region, and it is to works of this sort, based on less than a world viewpoint, that we owe much of the confusion in names with which we now contend, because the names were thereby brought into common usage. A monograph of a genus or large group for the world will give the only sound results, both taxonomically and nomenclaturally. There have been works of this nature in many groups and at many times, but no decade produced enough to claim a stabilizing effect on all zoological nomenclature.

A publication that has the appearance of being a monographic study may fall far short of complete or adequate treatment. For example, a recent work on a world-wide genus of insects, purported to deal with all the known species. It gives keys and descriptions and distribution and was based on extensive material obtained from all over the world. The work thus purports to be a monograph of the genus. Yet on closer examination it appears that at least half of the specific names that had previously been used in the genus are not mentioned, and numerous cases of homonymy and objective synonymy are completely overlooked. Even if the zoological aspect of this study is thoroughly and competently treated, the nomenclatural treatment is so bad that the revision is nearly useless. It is even possible to find the genotype of one subgenus listed in a different subgenus! To accept this work as a monograph for the purpose of stabilizing names would mean throwing overboard not only the principle of priority but also the concept of genotypes as the anchor of generic names and the requirement of thoroughness and accuracy for general acceptance.

In short, the only way to define a monograph in the sense of Heikertinger would be to set up an authority to pass on each publication. Acceptance of any given work as a monograph on a certain group of animals would automatically set up a list of *nomina conservanda* for both genera and species in that group, except for changes required on taxonomic grounds, as will be discussed under question 5.

(2) Disagreement between monographers would be taken care of by the authority mentioned above. If the acceptance of one work as a "monograph" did not serve to discourage a later work on the same subject, the authority would have to pass on the later work when it appeared. Rejection of the later work would uphold the earlier one, but acceptance of the later one would perhaps reverse some nomenclatural as well as taxonomic decisions and cause name changes.

(3) Many apparently nomenclatural decisions are based at least in part on purely taxonomic considerations. Under the law of priority, the correct name for any species is the oldest nonpreoccupied name that has been applied to it, *assuming that unrecognized biological identity with another so-called species does not exist.* This assumption is seldom expressed but always exists. When it can be demonstrated that there *is* taxonomic identity, there is certain to be a change in the status of one of the names. This change is nomenclatural and is made because of the law of priority, and yet abolition of that law would not prevent the change because of the biological considerations.

Nomenclaturally we hold that each genus must have a type species. The actual identity of that species cannot be determined nomenclaturally, however, for it is

necessary to make at least a morphological study of the type specimens of that species to demonstrate its characteristics. Under a recent interpretation, apparently employed by the International Commission in Opinions 168, 169, 173, 175, 177, 179, and 181, it is even necessary to examine the specimens that were before the worker who subsequently selected the genotype. These are biological considerations, although the problem of genotype fixation is generally thought of as primarily nomenclatural.

It is simply impossible in many cases to separate taxonomic from nomenclatural considerations, and if nomenclatural problems are to be decided by the whim of a monographer, it is difficult to see how we can prevent confusion of the taxonomic facts. Dr. Smith interprets Heikertinger's position thus: "These zoological monographs, one is led to believe, should be preferred to the older often superficial works, even when the monographic concept of a species differs from the original concept, and even when this difference in concept is caused by the monographer's misinterpretation of an earlier writer's type specimen."

(4) Heikertinger appears to believe that a monographer will always be in a position to make a sound decision on which name is in current use. Yet very few studies take into account *all* the previous literature and *all* the previous specimens. In actuality our monographs vary from this down to mere compilations or condensations which critically evaluate none of the previous work.

Some decisions of some monographers would inevitably be demonstrated to be based on inadequate or erroneous data. To refuse to reverse such a decision would be ridiculous, yet the principle of continuity would require just that.

If writer Jones finds that *P. niger* is in use and is to be retained over the older *P. obscurus*, does this decision give permanence to *P. niger* even when it is pointed out that Jones failed to note that *niger* is a junior homonym? This is a strictly nomenclatural change, but if both *nigers* are in current use, continuity could save only one of them.

In view of the low quality of the bibliographic work of some monographers, it is likely that in some cases a later monographer would be able to prove that the first monographer failed to consider a large number of pertinent works which would tend to reverse his decision. One world authority on a family of insects is unable to keep track of even his own proposals. He has repeatedly used a name in one genus not twice but three times. In one case, discovering the homonymy of two of his names he renamed the younger. The new name was promptly recognized (by another worker) as a homonym of another of his and renamed. Several years later this writer *rediscovered* the original homonymy and again renamed it, using the same new name as before, now twice a homonym as well as a junior synonym. This same writer habitually pays no attention to genotypes. It is not difficult to believe that any nomenclatural decision he made in a monograph or elsewhere is at least likely to be seriously defective.

(5) It is a popular pastime among certain biologists to ridicule the taxonomists for the large number of name changes that are made, generally implying that it is because of religious fervor for certain Rules of Nomenclature that such changes are proposed. In this way nomenclature is often made to take the blame for all changes of name. There can be little doubt that this is a most misleading assumption. Many names are changed because of discovery of older synonyms or the recognition of forgotten homonyms of prior date. These are the only truly nomenclatural changes. But many more changes are made (at least in some groups of organisms) because of generic transfer, proposal of segregate genera, recognition of generic equivalence, and similar purely biological considerations. And many are made because of nomenclatural requirements growing out of zoological actions, such as renaming of concurrent homonyms produced by union of genera. In many groups it is not difficult to demonstrate that a substantial majority of changes of names over a period of years has been caused by the second and third means listed above, namely those involving zoo-

logical actions rather than exclusively nomenclatural ones. These changes can not be prevented at all by the "principle of continuity."

If Heikertinger's proposition were to be adopted and means provided to make it work, we would still have changes of names as long as students search out new facts of relationships of organisms. Some changes would be prevented, it is true, but these could probably be prevented more easily by other means.

The overemphasis on the need for complete stability of nomenclature is demonstrated by a quotation by Dr. Smith from a German botanist. This botanist contends that we fail in our responsibility to our studying youth by making them unlearn the names each semester to follow the latest changes. Dr. Smith replies that this exaggerated statement "scarcely causes us to shed a tear, since this same (student) is expected to discard preconceived notions of all other branches of biological science at the drop of a chromosome. Why is it that workers in other fields of biology expect absolute stability of systematics (that is, comparative morphology and its attendant nomenclatural expression), while they are willing to accept any degree of flux in the fields of genetics, physiology, cytology, and . . . sociology?"

The reason for this emphasis on stability is doubtless the desire of these scientists to have means of tying their experiments and theories definitely to specific kinds of organisms, in order to use them for synthesis and generalization. But this desire for fixed names is impossible of gratification under any system as yet dreamed of and should not be given consideration over the necessity of the science of taxonomy for growth and development itself. All means should be found to prevent unnecessary changes of names, but it is not to be expected that a rapidly growing science like taxonomy can be for long conducted with an unchanging set of tools. Nomenclature will become stable only when monographs of high quality have been produced, based on all possible material, bibliographic sources, and techniques, and even these cannot be expected to stand indefinitely against new information and conceptions.

Dr. Smith criticizes the attitude of certain non-taxonomists as follows: "Too many criticisms of the present Rules of Nomenclature are based upon the assumption that professional systematists are playing a malicious game which has no relation to the biological sciences. The authors of these criticisms tacitly assume that systematists already have reached all the conclusions necessary regarding the classification of plants and animals, and that only their innate perversity prevents them from publishing a final and immutable list of the "correct" names of all living things. Immutability is not to be found in science, least of all in a virile branch like systematics, which builds upon facts disclosed by many other disciplines, each of which in itself is vigorous and, as human endeavor goes, young."

Systematists can find many reasons for wanting to reduce to a minimum the changes of scientific names, but this does not mean that absolute stability is the principal goal of systematics or of nomenclature. The goal of systematics is to discover the relationships between organisms so they may be classified in a usable system. The goal of nomenclature is to provide a method of designating the organisms explicitly, with as much uniformity and permanence as the growth of the classification permits. Any proposal that rates stability ahead of the advancement of the science of systematics or the development of one of its myriad components is a backward step and one doomed to ultimate failure and discard.

BOTANY.—*Studies in* Lonchocarpus *and related genera, IV: The* Lonchocarpus rugosus *complex and additional Middle American species.*[1]

FREDERICK J. HERMANN, U. S. Department of Agriculture.

In Part II of this study (Journ. Washington Acad. Sci. **38**: 11–14. 1948) an attempt was made to dispose of the various species of *Lonchocarpus* described from Middle America since the publication in 1917 of Pittier's monograph of the species known from that area. Because of lack of herbarium material, however, 17 of these names could not at that time be taken into consideration. Specimens of 10 of these have subsequently become available, through the courtesy of Dr. C. L. Lundell and of the Chicago Natural History Museum, and the result of their study is presented herewith. Several of the names prove to be referable to the protean *L. rugosus* Benth., so a brief discussion of the variations exhibited by that species is appended.

Lonchocarpus apricus Lundell, Lloydia **2**: 90. 1939 = L. RUGOSUS Benth., Journ. Linn. Soc. **4**: 92. 1860; Standley & Steyermark, Fieldiana, Botany, **24**(5): 283–284. 1946.

It was not found possible to correlate with other characters the "numerous approximate lateral veins of the leaflets" by which *L. apricus* was originally set off from *L. rugosus* and *L. hintoni*, nor is this character constant or of geographical significance. Further "differences in pubescence flower size, number of ovules, and leaf form" ascribed to the plant were not detected except in so far as the cited material showed a somewhat more appressed pubescence than most of the collections from Campeche where Bentham's type originated. This, however, is clearly a tendency only and is apparently an ecologic response rather than the result of geographic factors.

Lonchocarpus belizensis Lundell, Wrightia **1**: 55. 1945 = L. LUTEOMACULATUS Pittier, Contr. U. S. Nat. Herb. **20**: 64. 1917.

Although the petals of *L. belizensis* are described in the original description merely as dark red, the standard shows a well-defined yellow area in the center. This and the large size of the standard indicate that the alliance of the plant is with *L. luteomaculatus* rather than with *L. latifolius*.

Pittier's key (Contr. U. S. Nat. Herb. **20**: 51–52. 1917) does not satisfactorily separate *L. latifolius* from *L. luteomaculatus*. One of the few reliable differences between the two appears to be in the shape of the pods. In *L. latifolius* these are elliptic and pointed at both ends; in *L. luteomaculatus* they vary from almost circular to oblong with rounded ends. The length of the standard (6 mm in *L. latifolius*, 10 mm in *L. luteomaculatus*) also seems to be constant. *L. latifolius* frequently has a yellow-centered standard like that of *L. luteomaculatus* but when it does it is a less well-defined "spot" or area and shades off into the red background. The inflorescence in *L. latifolius* tends to be in the form of simple racemes in the upper leaf axils; in *L. luteomaculatus* the racemes are more often compound, or the upper internodes are so greatly shortened that the numerous racemes become crowded and appear to be fastigiate and terminal or nearly so, and at times the inflorescence actually becomes a terminal panicle.

Lonchocarpus chiapensis Lundell, Wrightia **1**: 152. 1946 = L. PENINSULARIS (Donn. Smith) Pittier, Contr. U. S. Nat. Herb. **20**: 56. 1917.

The specimen (*Inst. Fis. Geogr. Costa Rica 13966*) from which the characteristics of the fruit in Pittier's description of *L. peninsularis* were drawn (Contr. U. S. Nat. Herb. **20**: 57. 1917) has ovate, 1-seeded pods only (and these, incidentally, are decidedly overripe, hence the "remarkably recurved carinal margin" which is consequently an infrequently seen condition). Plants with oblong, 2- and 3-seeded legumes are also common, and often both types are found in a single inflorescence as in the type of *L. chiapensis* (*Matuda 5008*). A similar situation obtains in *L. luteomaculatus*. The leaflets in *L. chiapensis* are conspicuously punctate, a characterjstic omitted from the original description. In other respects, as well, the type collection closely matches authentic material of *L. peninsularis*.

Lonchocarpus cruentus Lundell, Wrightia **1**: 55. 1945 = L. SERICEUS (Poir.) HBK. Nov. Gen. & Sp. **6**: 383. 1823.

The type of *L. cruentus* has the nerves on the

[1] Received June 15, 1948.

upper surfaces of some of the leaflets as strongly impressed as any to be found in *L. sericeus*. Truly impressed nerves in *L. sericeus*, however, are not the prevailing condition; only in unusual cases can they be said to be plainly impressed. The one difference detected between *L. cruentus* and the prevalent form of *L. sericeus* was in the calyx length of 2.5–4 mm, rather than 5 mm, but the form with shorter calyx not infrequently turns up elsewhere, as in *Eggers 1432* from Trinidad (calyx 3 mm long).

Lonchocarpus gillyi Lundell, Wrightia 1: 56. 1945 = L. RUGOSUS Benth., Journ. Linn. Soc. 4: 92. 1860.

Leaflet size appears to be an altogether unreliable diagnostic feature in *L. rugosus*. In the majority of instances they may be larger in that species than are those in the form proposed as *L. gillyi*, yet in some specimens of otherwise typical *L. rugosus* they are even smaller. The fact that the racemes are borne on the old wood in the type of *L. gillyi* is taxonomically meaningless. Among others *Matuda 4020*, referred by the author of *L. gillyi* to his *L. apricus*, likewise has the racemes borne on the old wood; and the type of *L. hidalgensis* Lundell has inflorescences on both the old and the new branches.

Lonchocarpus hidalgensis Lundell, Wrightia 1: 153. 1946 = L. RUGOSUS Benth., Journ. Linn. Soc. 4: 92. 1860.

The purportedly distinguishing character of axillary racemes in *L. hidalgensis* is found also in *L. gillyi;* in the Chicago Natural History Museum sheet of *Lundell 857*, referred by its collector (Lloydia 2: 92. 1939) to typical *L. rugosus*, and in *Matuda 4525*, referred in the same paper to *L. apricus*. Other peculiarities characterizing *L. hidalgensis* represent variations too unstable to merit nomenclatorial recognition.

Lonchocarpus hintoni Sandwith, Kew Bull. Misc. Inf. 1936: 4. 1936 = L. RUGOSUS var. **hintoni** (Sandwith) comb. nov.

This appears to be the only variant of *L. rugosus*, of the several recently proposed as specifically distinct, deserving of taxonomic status. So far as known, it is geographically segregated in the Mexican States of Michoacán, Guerrero, and México, and is distinguished from typical *L. rugosus* by the cinereous strigosity of the leaves (except the upper surfaces of the leaflets which tend to be glabrous and shining at maturity)and inflorescence, this being especially pronounced on the pods which are firmer and more coriaceous than in other forms, and by flowering before the leaves expand. These characteristics are striking in their extreme form, particularly in flowering or fruiting specimens, but they show considerable variation and sterile material very often is decidedly intermediate.

The locality cited for the Langlassé collection (*No. 108*) in the original description of *L. hintoni* apparently is in southeastern Michoacán rather than in Guerrero.

Lonchocarpus nicaraguensis Lundell, Wrightia 1: 154. 1946 = L. PENINSULARIS (Donn. Smith) Pittier, Contr. U. S. Nat. Herb. 20: 56. 1917.

The nonimpressed nerves and the clearly punctate leaflets (the latter feature, however, not noted in the original description) of the type material of *L. nicaraguensis* may well have been the reason for its affinity having been surmised to be with *L. michelianus* rather than with *L. peninsularis*. The misplacement of the latter species in Pittier's key (Contr. U. S. Nat. Herb. 20: 51, where it is placed under section *Spongopteri* of series *Impressinervi* instead of under section *Punctati* of series *Planinervi*) was the apparent cause of the proposal of at least two other synonyms, *L. kerberi* Harms and *L. purpusii* Brandegee (cf. Journ. Washington Acad. Sci. 38: 13. 1948), of this common species.

Lonchocarpus phlebophyllus Standl. & Steyerm., Field Mus. Publ. Bot. 23(2): 56. 1944.

This appears to differ from *L. eriocarinalis* Micheli only in its apparently consistently 5-leaflets (rather than 7–11) with more numerous nerves. The vein-number has proved to be of negligible diagnostic value in the closely related *L. rugosus*, but it is possible that when flowering material of *L. phlebophyllus* has been collected additional characters may be found which could be correlated with the anomalous leaflet number.

Lonchocarpus whitei Lundell, Wrightia 1: 154. 1946 = L. MINIMIFLORUS Donn. Smith, Bot. Gaz. 44: 110. 1907.

In the publication of this name no affinity with other species was suggested, but the type

material (in fruit) compares well in all respects with typical *L. minimiflorus*, and *White & Gilly 5367* shows the very short, densely sericeus standard which sets off this species from its allies in the Series *Pubiflori*.

LONCHOCARPUS RUGOSUS Benth.

This is the most plentiful of the Middle American Lonchocarpi. It is also the most polymorphic of all the species in the genus, not only in shape, size and venation of the leaflets, in vesture and in stipule characteristics but also strikingly so in its pods. Consequently its variations include much greater extremes than those that have been singled out as the bases for most of the recently proposed segregates. On the basis of a single character most of the specimens may be readily assorted into two groups, but the substitution of a second, equally well-marked, characteristic results in a very different composition of the two groups. Furthermore, as soon as a correlation is attempted between two or more of the differentiating features (with the single exception of var. *hintoni*), the number of recalcitrant intermediates becomes disconcerting, as has been pointed out by Standley and Steyermark in their discussion of *L. apricus* (Fieldiana, Botany, **24**(5):284. 1946).

Among the most outstanding forms of the species are those characterized by divergence in type of pubescence. A copious, shaggy type of villosity found in combination with very large (9×2.5 cm), few-nerved leaflets and large, widely divaricate, persistent stipules in *Steyermark 45744* from Guatemala is so striking that this plant at first appears to have little in common with *L. rugosus*. This villosity reappears in a similarly pronounced degree in *Schipp 503* from British Honduras, but is here associated with small, ascending caducous stipules and moderately nerved leaflets of average size (4×2 cm). Between this overdeveloped villosity and the prevalent form with short, only moderately dense villosity, an extensive series of transitional stages is found in innumerable combinations with other characters. In other collections the vesture fluctuates toward either of two additional extremes; a dense tomentum in such individual plants as *Hinton 6325* from Mexico and *Steyermark 51554* from Guatamala, or a comparatively sparse strigosity represented by *Standley 19254* from El Salvador.

A similarly extensive range of fluctuation is evident from a comparison of the legumes, from the standpoint of their shape, size, texture, type of pubescence or number of seeds; of the leaflets, from the standpoint of number, size, texture, venation, or type of apex or base; or of the characteristics of the inflorescence. And in each case a similar lack of consistency, a refusal to submit to the taxonomist's penchant for pigeon-holing, will be noted.

Extensive field acquaintance with *Lonchocarpus rugosus* would doubtless be helpful in suggesting explanations for its seemingly unpredictable behavior. From herbarium evidence alone conjectures are risky, but it seems not altogether improbable that frequently sufficient allowance has not been made for the influence of environmental factors upon the species, since it is not only one of the most widely distributed of the Lonchocarpi but is to be found in a greater diversity of habitats than the majority of its congeners.

BOTANY.—*New species of* Salix *from Szechwan, China.*[1] WEN-PEI FANG, National Szechwan University, Chengtu, Szechwan. (Communicated by EGBERT H. WALKER.)

The four new species of willows described herein were found among the numerous collections that have been made in Szechwan Province, China, in recent years. The types are deposited in the herbarium of the National Szechwan University at Chengtu. Duplicates are being distributed to various herbaria in China and the United States.

[1] Received April 22, 1948.

1. **Salix triandroides** Fang, sp. nov.

Frutex parvus, 2 m altus, cortico laevi, flavescenti- vel fusco-cinereo. Ramuli erecti, cylindrici, hiemales dense nigrescenti- vel fusco-tomentosi, vernales glabrescentes. Gemmae ovoideae, 8 mm longae, perulis late ovatis extrinsecus dense cinereo-tomentosis. Folia alterna, chartacea, glabra, lanceolata vel oblanceolata, rarius oblongo-ovata vel oblongo-obovata, 3–5 cm, rarius ad 12 cm longa, 1–1.5

cm, rarius ad 2.2 cm lata, apice caudato-acuminata vel breviter acuminata, basi late cuneata, margine glanduloso-serrulata, supra atroviridia, subtus pallidiora; costa media supra obscura subtus prominens; nervi laterales utrinsecus 5–20, obsoleti; petioli cylindrici, 8 mm longi, glabri, supra canaliculati, subtus rotundati. Flores coetanei, amenta mascula 2–2.5 cm, rarius ad 3 cm longa, flava vel viridi-flava, densiflora, rhachi albo-pilosa et albo-pubescente; pedunculi 5–8 mm longi, pubescentes, foliis 2 vel 3 suffulti; bracteae flavae vel fusco-flavae, obovatae, 2 mm longae, utrinque pilosae. Stamina 3, filamentis gracilibus 3 mm longis basi villosis, antheris flavis ovalibus, glandula ventrali simplici flava oblongo-conicali, glandula dorsali simplici flava oblonga. Amenta feminea alterna, 2.5–3 cm longa, viridia, densiflora, rhachi cinereo-pubescenti vel pilosa; pedunculi 1–1.5 cm longi, foliis obovatis 2 vel 3 suffulti; bracteae flavescenti-virides, oblongae, 2–3 mm longae, extrinsecus albo-pilosae, intrinsecus glabrae; ovaria conico-ovoidea, 5 mm longa, viridia, glabra; pedicelli 1–1.5 mm longi, glabri; stylus brevior; stigmata divergentia; glandula ventralis flava, oblongo-ovoidea. Amenta fructifera 3–3.5 cm longa, capsulis conico-ovoideis 5 mm longis flavescenti-viridibus; bractea extus albo-pilosa; pedicelli 1–1.5 mm, longi, tenues, glabri.

EAST OF CHENGTU: Tsing-chu-ssu, *W. P. Fang 19427* ♀, *19598* ♂, *K. Y. Ning 7660* ♂; Kuan-ying-chiao, *W. P. Fang 19411* ♂; Wu-kuai-chiao, *K. Y. Ning 7910* ♀, *7918* ♀. SOUTHEAST OF CHENGTU: Near Wang-kiang-lau, *K. Y. Ning 7953* ♂, *7954* ♂, *7955* ♂; campus of National Szechwan University, *W. P. Fang 19604* ♀, *19605* ♀, *19605A* ♂, *19606* ♂, *19608* ♂, *19611* ♀, *19617* ♀; T'ou-wa-you, *W. K. Hu 7694* ♀, *7695* ♀, *W. P. Fang 19376* ♀, *19416* ♀, *19415* ♂, *19417* ♂, *19418* ♂, *K. Y. Ning 7917* ♂, *7938* ♂, *7939* ♂; Chung-shu-chiao *W. K. Hu 7633* ♂, *7639* ♂; Kao-pan-chiao, *W. P. Fang 19370* ♂, *19379* ♂, *19383* ♀, *19385* (type) ♀, *19435* ♀, *19516* ♀, *19637* ♀. SOUTH OF NEW VILLAGE OF CHENGTU: *W. P. Fang 19322* ♀, *19393* ♂, *19440* ♀. WEST OF CHENGTU: Chia-tien-tzu, *K. Y. Ning 7962* ♂. NORTHWEST OF CHENGTU: Tu-chu-miao, *K. Y. Ning 7947* ♂, *7848* ♂.

This new species is nearly always found by a stream, occasionally by the roadside. All the cited specimens were collected in the month of March, 1945–1947, except *K. Y. Ning 7917* and *7933*, staminate specimens collected on February 16, 1946. Fruiting specimens may be found late in March.

This species is quite distinct from all the known species. It may be near *Salix triandra* L., from which it differs in its shrubby habit with blackish-gray, densely tomentose branchlets in winter, in its short staminate catkins with oblanceolate bracts which are pilose on the outer surface, in its pistillate catkins with glabrous ovaries and oblanceolate bracts which are longer than the pedicels, and in the lanceolate leaves which are pale green but not glaucous below. *Salix triandra* L. is widely distributed in Europe, northern Asia, and northern Africa, but in China it occurs only along the eastern coast from Manchuria to Kiangsu. This new species is fairly common along the streams in the vicinity of Chengtu. The young leaves of the flowering branchlets are ovate or obovate, but adult ones on the leafy branches are usually lanceolate, and those from the stout branches are exceptionally large in size.

2. **Salix neowilsonii** Fang, sp. nov.

Arbor 6–15 m alta, cortice fusco-cinereo sulcato. Ramuli erecti, teretes, graciles, glabri; hornotini purpureo-virides, annotini fusco-virides vel pallido-virides. Gemmae conoideae, 6 mm longae, perulis late ovatis fuscis pubescentibus; bracteae 2, obovatae, membranaceae, fusco-virides. Folia alterna, chartacea, glabra, lanceolata, 6–14 cm longa, 2.5–4 cm lata, apice acuminata vel abrupte acuminata, basi cuneata, margine adpresse glanduloso-serrulata, supra atroviridia, subtus pallidiora, costa media supra distincta, subtus prominente, nervis lateralibus utrinsecus 25–30 obsoletis; petioli graciles, 1–2 cm longi, supra canaliculati, primum pubescentes et purpurescentes, adulti glabri et virides, tandem rubri, apice 2- rarius 4-glandulosi; stipulae deciduae. Flores coetanei; amenta mascula viridi-flava, cylindrica, 3.5–4.5 cm, rarius ad 6.5 cm longa, laxiflora; rhachis albo-pubescens; pedunculi 7–10 mm longi, albo-pubescentes, foliis 2–6 suffulti; bracteae oblongae, 2 mm longae, flavescenti-virides, extrinsecus sparse pubescentes, intrinsecus pubescentes et margine ciliatae. Stamina 3–5, inaequalia, plerumque 2 longiora circa 4 mm longa, 3 breviora circa 2 mm longa; filamenta gracilia, sursum glabra, basi villosa; antherae subovoideae, flavae, glandulis ventralibus et

dorsalibus flavis pseudodiscum formantibus. Amenta feminea et fructus ignoti.

EAST OF CHENGTU: Near Tsing-chu-ssu, *W. P. Fang 19403* (type). SOUTHEAST OF CHENGTU: Wang-kiang-lau, near Lei-shun-miao, *K. Y. Ning 7956*, *W. P. Fang 19616*, *19628*, *19378*, *19405;* campus of National Szechwan University, *W. P. Fang 19414*, *19610;* T'ou-wa-you, *K. Y. Ning 7931*, *7932*, *7934*, *W. P. Fang 19414:* near the Arsenal, *K. Y. Ning 7937*, *W. P. Fang 19433*, *19434;* Kao-pan-chiao, *K. Y. Ning 7948*. SOUTH OF CHENGTU: Outside the new south gate, *W. P. Fang 19390;* Hua-hsi-pa, *W. P. Fang 19390A*. WEST OF CHENGTU: Tsing-young-kon, *K. Y. Ning 7981;* Tao-chu-miao, *K. Y. Ning 7949;* Cha-tien-tzu, *K. Y. Ning 7964;* King-niu-pa *K. Y. Ning 7972*, *7976*. NORTHWEST OF CHENGTU: Chiang-chun-pao, *K. Y. Ning* 7981; Chung-cheng Memorial Park of Chengtu, *W. P. Fang 19634* (cultivated). SOUTHWEST OF CHENGTU: Pei hua-tan, *W. P. Fang, 12041*, *13272*.

This new species is closely related to *Salix wilsonii* Seemen but is separated easily from that species by the branches and leaves which are glabrous even during the young stage, by the petioles which are provided with 2 or 4 glands near the apex, and by the oblong bracts which are pubescent on the inner surface. Although we have not yet found the pistillate flowers, the material on hand is sufficient to indicate an undescribed species. The tree is usually cultivated as an avenue-tree in the vicinity of Chengtu.

3. **Salix hsinhsuaniana** Fang, sp. nov.

Frutex 1 vel 2 m altus, cortice nigrescenti-cinereo laevi. Ramuli graciles, teretes; hornotini pubescentes; annotini glabrescentes, purpureo-virides. Gemmae conicae, fusco-purpureae, glabrescentes. Folia decidua, alterna, chartacea, elliptica vel elliptico-oblonga vel elliptico-oblanceolata, 2–2.5 cm longa, 8–10 mm lata, apice obtussa vel subrotundata, basi obtusa vel late cuneata, margine integra, supra atroviridia, glabra, costa media puberula excepta, subtus viridia, juvenilia sparse tomentosa vel villosa, maturitate glabrescentia; costa media supra depressa subtus conspicua; nervi laterales utrinsecus 8–10 supra obsoleti, subtus conspicui; petioli 2–3 mm longi, juveniles pubescentes, maturitate glabri. Flores serotini; amenta masculina fusco-flava, densiflora, cylindrica, 2–2.5 cm longa, 7 mm crassa, rhachi albo-villosa; pedunculi 1–1.2 cm longi, pubescentes, foliis normalibus 3–4 suffulti. Stamina 2 plerumque 3 mm longa; filamenta gracilis, glabra nisi ad medium villosum; antherae subglobosae, fusco-purpureae; bracteae ovatae, 0.8 mm longae, glabrae, margine ciliatae; glandulae ventrales purpurescenti-flavae, oblongae, plerumque 0.2 mm longae. Amenta feminea densiflora, cylindrica, 3–4 cm longa, 6 mm crassa, rhachi villosa; pedunculi 1–1.5 cm longi, cinereo-villosi, foliis normalibus 2–3 suffulti; ovaria sessilia longo-conico-ovoidea, 2 mm longa, fusca, glabra, stylis gracilibus 2-lobatis, stigmate subcapitato; bracteae suborbiculares, 0.4 mm longae, glabrae, margine sparse ciliatae; glandulae ventrales flavae oblongae, quam bracteae breviores. Capsulae sessiles, 5 mm longae.

SZECHWAN: Mount Omei: Chin-ting, alt. 3135 m, *H. C. Chow 7670* June 27, 1938 (pistillate flower, type); en route from Chin-ting to Chien-fu-ting, alt. 3150, common in thickets, *C. L. Sun 445*, June 10, 1939, Chien-fu-ting, alt. 3,150 m, *T. C. Lee 2846*, July 18, 1940 (typical of fruit), *W. P. Fang 19002*, June 18, 1942 (typical of staminate flower).

SIKANG: Tien-chun-hsien (formerly known as Mupin), *K. L. Chu 2317*, April 12, 1937.

This new species is near *Salix luctuosa* Léveillé, from which it differs in the bracts of both staminate and pistillate flowers, which are glabrous on both surfaces, although they are ciliate on the margin, and in the ventral glands which are much shorter than the bracts.

This new species is named in honor of Prof. Hsin-hsuan Chung, of the National Wuhan University, under whose direction H. C. Chow made several expeditions on Mount Omei. The pistillate flower is here described from a duplicate set of their collections kindly sent by Professor Chung.

4. **Salix chuniana** Fang, sp. nov.

Frutex 3–5 m altus, cortice nigro-fusco. Ramuli graciles, teretes; hornotini virides vel purpureo-virides, pubescentes; annotini flavescenti-fusci vel nigro-fusci, glabri. Gemmae conicae, 7 mm longae, fuscae, sparse puberulae. Folia alterna, chartacea, lanceolata, basi late cuneata vel subrotundata, margine leviter appresso-serrulata, supra atroviridia, juvenilia sparse pubescentia, maturitate glabrescentia,

costa media pubescenti excepta; nervi laterales plerumque obsoleti; folia subtus cinerescenti-viridia, leviter glauca, flavescenti- vel albo-sericeo-tomentosa; costa media prominens; nervi laterales utrinsecus 11–13, conspicui, incurvati; petioli graciles, 5–8 mm longi, supra canaliculati, subtus rotundati, tomentosi vel pubescentes. Flores serotini; amenta masculina ignota; amenta feminea laxiflora cylindrica, 4.5–5 cm longa, 4 mm lata, basi efoliosa; rhachis pubescens; pedunculi 5–7 mm longi albo- vel flavescenti-pubescentes; bractae oblongo-ovatae 0.5–0.8 mm longae, utrinsecus albo- vel flavescenti-sericeo-tomentosae; ovaria subsessilia, conico-ovoidea, 2 mm longa, sparse glandulosa ad basin et plerumque sparse villosa, stigmate 3- vel 4-lobato, glandula ventrali flava, lineari, 1 mm longa, plerumque quam bractae longiore ovarium medium aequante. Fructus subsessilis; capsula 5 mm longa sparse villosa.

SZECHWAN: Mount Omei: Tsuan-tien-po, alt. 2000 m, in thickets, *C. L. Sun* 284 (type); Opien-hsien, Wa-shan, in forests, *C. L. Sun* 1073; Mount Omei, *W. C. Cheng 10314, C. W. Yao 2315, 2345, 3866.*

All were pistillate specimens collected in May except *Sun 1073* in fruit collected in August.

Although the staminate flower has not been seen, this is a very distinct new species in the section *Chingianae* Hao. It is near *Salix rehderiana* Schneider in general appearance but differs in the habit of flowering after the leaves and in the pedunculate long and narrow pistillate catkins, which are leafless at the base. The flowers of *Salix rehderiana* are precocious and the sessile catkin is just 2.5 cm in length and 8 mm in width, and provided with two or three normal lanceolate leaves at the base of the inflorescence.

This new species is named in honor of my former teacher, Prof. Woon-Young Chun, the founder of the Botanical Institute of the National Sun Yatsen University at Canton, and the leading systematic botanist in China, for his unceasing devotion to floristic investigation and his encouragement to young botanists.

ENTOMOLOGY.—*Two new Ithomiinae in the Schaus collection (Lepidoptera: Nymphalidae).*[1] RICHARD M. FOX, Pittsburgh, Pa. (Communicated by E. A. CHAPIN.)

The two butterflies described here are from the collection of the late Dr. William Schaus, which is now part of the United States National Museum collection of Lepidoptera. A few years ago the writer was invited by Dr. Schaus to study the ithomines he had accumulated, and through the courtesy of the National Museum and of the Academy of Natural Sciences of Philadelphia was enabled to do so. Some of the species and subspecies discovered among this material already have been published upon.[2]

Pteronymia schausi, n. sp.

This series, labeled "Colombia," approximates *P. tucuna* (Bates),[3] a number of specimens of which I have seen from northern Peru. There are many points of difference, however: The opaque costal spot of the forewing is less brilliantly yellow, is only half as long as in *tucuna*, and is cut off by the brown R_s (this is yellow in *tucuna*). The end of the cell, is yellow-transparent, the base yellow-orange-transparent and R and the cubitus are very narrowly red-tawny. The spots in the transparent areas of the rest of the wing are smaller, more translucent than in *tucuna;* these are located as follows: A yellow-transparent spot beyond the narrow, pointed brown discocellular band, crossing the base of M_1, cut off at M_2; a tiny yellow-white-transparent spot halfway to the margin in M_2-M_3; a series of submarginal whitish-transparent spots R_s to Cu_2, the last of these elongated. The anal border fills the space posterior of cubitus-Cu_2.

The hind wing has an even border, brown-black, 1 to 2 mm wide, the cell and part of the disc toward the anal margin suffused with yellow-orange, the veins here yellow-brown. Between this suffused area and the opaque

[1] Received March 7, 1948.

[2] FOX, R. M. *New Ithomiinae*, Sci. Publ. Reading Public Mus. 2: 34 pp., 2 pls. 1941.

[3] BATES, H. W. Trans. Linn. Soc. London 23: 544. 1862. (São Paulo, Amazons.)

marginal color there is a colorless transparent lunate line traversed by brown veins running from Cu_2 to the wing apex.

Beneath as above, but the borders filled with rusty-tawny; three tiny white admarginal spots in the forewing apex; the hind wing with a series of oval white admarginal spots M_1 to 2A, paired Cu_1-2A; costal margin rusty-tawny. the humeral angle yellowed.

Antennae black with orange-brown clubs; thorax black-brown with white scaling; abdomen brown above, yellow beneath.

Type.—Male; Colombia; coll. Wm. Schaus; U.S.N.M. no. 58560.

Paratypes.—5 males, same data; 2 Academy of Natural Sciences of Philadelphia, 2 U. S. National Museum.

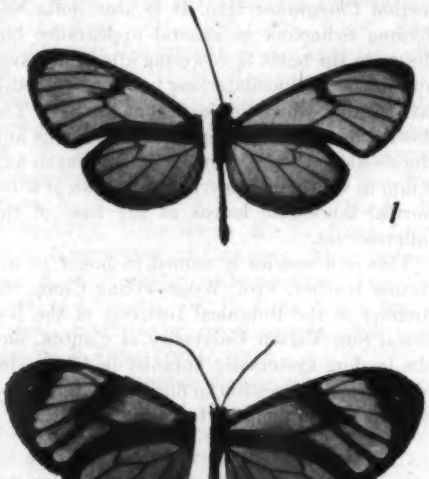

FIG. 1.—*Pteronymia schausi*, n. sp.: Type male, from Colombia; collection William Schaus.
FIG. 2.—*Hypoleria meridana*, n. sp. Type female, from Mérida, Venezuela. (Detached wings on left are under sides; wings on right are upper sides.)

Hypoleria meridana, n. sp.

This is related to *H. vanilia* (Herrich-Schäffer)[4], and might be taken for an aberrant individual. The postdiscal dark band is placed farther apicad, however, reducing the size of the subapical transparent spots R_s to M_2 and eliminating entirely the one in M_1-M_3. The white discal band is stronger; the tawny on the hind wing is reduced to a narrow edging on the proximal side of the border between Cu_1 and 2A. The white band of the forewing crosses R_s, M_1, and M_2, whitening these veins proximad and nearly filling the cells between the discocellular band and the postdiscal band, entirely filling M_3-Cu_1, although M_3 is narrowly black.

In other respects the colors and markings are exactly as in *H. vanilia*, of which this may be relegated eventually as a subspecies.

Type.—Female; Mérida, Venezuela; U.S.N.M. no. 58561.

[4] HERRICH-SCHÄFFER, G. A. W. Corr.-Blatt. Regensburg **18**: 175. 1864. (New Grenada.)

ZOOLOGY.—*A new subspecies of tree frog from Pernambuco, Brazil.*[1] DORIS M. COCHRAN, U. S. National Museum.

While studying the small hylas of Brazil, I noted differences between examples of *Hyla bipunctata* Spix from the state of Rio de Janeiro and four Pernambuco examples received from Dr. Thomas Barbour likewise identified as *bipunctata*. The Museum of Comparative Zoology kindly lent 16 additional frogs of the original series from Pernambuco. Their characters are stable enough to warrant their description as a new subspecies.

Hyla bipunctata branneri, n. subsp.

Diagnosis.—Closely related to *Hyla bipunctata* Spix, differing from it mainly in the absence of the purple areolate pattern on the sides of the snout, in the presence of a single silvery-white spot under the eye, in a less pronounced dorsal pattern, and apparently in smaller adult size (21.5 mm for ♀, 18 mm for ♂ in *branneri*, compared to 25 mm for ♀, 25.5 mm for ♂ in typical *bipunctata*).

Type.—U.S.N.M. no. 48861, an adult female from Bonito, Pernambuco, Brazil, collected by J. C. Branner for the Museum of Comparative Zoology, and donated to the U. S. National Museum in 1912. Paratypes: U.S.N.M. Nos. 48862–4 and M.C.Z. nos. 2827A–P, all with the same data as the type.

Description of the type.—Vomerine teeth in two small, well-separated patches between the choanae; tongue a little more than half as wide

[1] Received May 12, 1948.

as mouth-opening, rounded, notched and slightly free behind; snout short and rounded when viewed from above, truncate in profile, the upper jaw extending only slightly beyond the lower; nostrils superolateral, projecting, their distance from end of snout about one-third that to anterior border of eye, separated from each other by an interval equal to their distance from eye. Canthus rostralis not well defined, merging with the loreal region which is flat. Eye large, prominent, its diameter equal to its distance from end of snout; interorbital diameter about 1¾ times the width of upper eyelid, greater than distance between nostrils. Tympanum distinct, about one-third the eye diameter, separated from eye by an interval equal to two-thirds its own diameter. Fingers one-third webbed, fourth considerably longer than second; disk of third finger just covering tympanum; no rudiment of a pollex visible; toes three-fourths webbed, third a little longer than fifth; disk of fourth toe covering tympanum; a distinct, projecting inner metatarsal tubercle, but no outer one; no true tarsal ridges or heel appendages; metacarpal and metatarsal tubercles present. Body somewhat elongate, in the postaxillary region slightly narrower than greatest width of head; when hind leg is adpressed, heel reaches to nostril; when limbs are laid along the sides, knee and elbow touch; when hind legs are bent at right angles to body, heels considerably overlap. Skin of upperparts nearly smooth, with small pustules on shoulders and back of head; no pronounced ridge encircling upper part of tympanum; skin of throat and chest smooth in the female; in the male the throat is finely plicate because of the large vocal sac which covers the center and sides of the throat; skin of belly coarsely granular, that of posterior femur and anal region less heavily granular. A skin fold across the chest.

Color (in alcohol): Dorsum pinkish vinaceous to fawn color; a light-brown cross bar between the eyes, followed by a pale)(-shaped mark on the back extending to the sacral region. A metallic white mark below the eye extending to the upper lip border; remainder of upper lip finely punctate with gray dots, but with no alveolar pattern like that found in *bipunctata;* a wide dark canthal line edged narrowly with white above, continuing behind the ear and along the side of the body where it becomes less distinct as it approaches the groin; femur immaculate; upper surface of tibia with faint darker markings.

Variations: The white spot below the eye is very prominent in 18 of the 20 specimens at hand; in the remaining 2 it is somewhat reduced. The heel reaches from between center of eye to tip of snout, most often to nostril. In 3

TABLE 1.—MEASUREMENTS OF 20 SPECIMENS OF HYLA BIPUNCTATA BRANNERI, N. SUBSP.

Specimen	Sex	Total length	Head length	Head width	Femur	Tibia	Foot	Hand	% Head length	% Head width	% Femur	% Tibia	% Foot	% Hand
U.S.N.M. 48861	♀	21.5	6.5	6.5	10.5	11.5	9	5.5	30.2	30.2	48.8	53.4	41.9	25.6
48862	♀	20	5.5	6	9.5	11	8.5	6	27.5	30.0	47.5	55.0	42.5	30.0
48863	♀	19	6	6.5	9	11	8	6	31.6	34.2	47.4	57.9	42 1	31.6
48864	♀	14.5	4.5	5	7	7.5	5.5	4	31.1	34.5	48.3	51.8	37.9	27.6
M.C.Z. 2827 A	♀	18	6	6.5	9	10	8	5.5	33.3	36.0	50.0	55.5	44.5	30.5
2827 B	♀	16.5	5	6	8	9	7	4.5	30.3	36.4	48.5	54.6	42.5	27.3
2827 C	♂	17	5.5	5.5	8	8.5	7	5	32.4	32.4	47.1	50.0	41.2	29.4
2827 D	♀	19	6.5	6	9	9.5	8	5.5	34.2	31.6	47.4	50.0	42.1	29.0
2827 E	♂	17	5	5.5	8	8	7.5	5	29.4	32.3	47.1	47.1	44.1	29.4
2827 F	♂	17	5	5.5	8	9	7.5	5	29.4	32.3	47.1	53.0	44.1	29.4
2827 G	♂	16	5	5.5	7.5	8	7	4.5	31.3	34.3	46.9	50.0	43.8	28.1
2827 H	♀	19.5	6	6	9.5	10.5	7.5	5.5	30.8	30.8	48.7	53.9	38.5	28.2
2827 I	♂	17	5.5	5.5	8	9	7	5	32.3	32.3	47.1	53.0	41.2	29.4
2827 J	♂	16.5	5.5	5.5	7.5	8	7.5	4.5	33.3	33.3	45.5	48.5	45.5	27.3
2827 K	♂	16	5.5	5.5	8	9	7	5	34.3	34.3	50.0	56.2	43.8	31.3
2827 L	♂	17.5	5.5	5.5	8	9	7	5	31.4	31.4	45.7	51.4	40.0	28.6
2827 M	♀	17.5	5.5	5.5	9	10	7.5	5	31.4	31.4	51.4	57.2	42.9	28.6
2827 N	♂	16	5	5.5	8	9	7	5	31.3	34.3	50.0	56.2	43.8	31.3
2827 O	♂	18	6	6	7.5	9	6.5	5	33.3	33.3	41.6	50.0	36.0	27.8
2827 P	♂	17	5.5	5.5	8	8.5	8	4.5	32.3	32.3	47.1	50.0	47.1	26.5
				N=20				M=	31.6	32.8	47.7	52.7	42.3	28.8
								σ=	1.66	1.73	2.01	2.98	2.31	1.57
								V=	5.3	5.3	4.2	5.7	5.4	5.3
								σm=	0.37	0.39	0.45	0.67	0.52	0.35

specimens no dorsal pattern was visible; in 3, faint mottlings appeared; in 2, scattered spots occurred, while in the remaining 12, the)(-shaped pattern found in the type was fairly apparent.

ZOOLOGY.—*American Caudata IV: Allocation of the name* Bolitoglossa mexicana.[1] M. B. MITTLEMAN and HOBART M. SMITH. (Communicated by HERBERT FRIEDMANN.)

The most recent discussion (Smith, Herpetologica **3**: 17. 1945) of *Bolitoglossa mexicana* Duméril, Bibron, and Duméril 1845 (Erp. Gen. **9**: 93, pls. 104. 1845) concludes by allocating the name with *B. platydactyla* Gray, an earlier (1831) name. This action was based chiefly upon Brocchi (Miss. Sci. au Mexique, Batr., livr. 3: 113, pl. 18 bis. 1883), who illustrated four specimens, presumably cotypes of *mexicana*, one of which was indicated as "type," while each of the others was called "variété." All were stated to be from Veracruz, where only *platydactyla* (of the involved species) occurs.

In reality, as discovered by the senior author, the locality citation in the plate explanation is obviously in error. On page 114 Brocchi clearly selects (from the extraordinary mixture of specimens of *bellii*, *platydactyla*, and a species from Petén, Guatemala, that together comprise the cotypes of *B. mexicana*) the two Petén specimens as types. Brocchi's text may be translated literally as follows (1883: 114):

> *Coloration.*—The coloration varies considerably. In the type, the body is a uniform reddish brown; the same coloration is found on the upper parts, but there may be made out numerous spots of a distinct light hue. These spots, which are orange, are disposed to form three longitudinal and parallel bands in one of the examples sent by M. Morelet, and form a kind of mantle in the other specimen; in this latter, there are on the surface of the mantle a number of spots which again show the basic reddish brown color (figs. 3 and 4).

That Brocchi in this discussion actually selected one of the two as the type is debatable, but he may be considered to have clearly indicated his type through a combination of the above text, plus the legend to his plate 18 bis, and figure 3 of this plate, which the legend designates as the type from "Vera Cruz." This figure exactly matches the description for the first Morelet specimen ("These spots, which are orange, are disposed to form three longitudinal and parallel bands in one of the examples sent by M. Morelet."). Brocchi's reference to figures 3 and 4 in the passage quoted above, as well as his ascribing a Veracruzan origin to the type, figure 3, in the accompanying legend, seems explainable as a simple *lapsus*. That this is the case is borne out by comparing his figure 4 with his description of "Variété I," which fits the figure very well. This specimen is listed, under "Variété I," as coming from "Mexico" (although the plate legend states "Vera Cruz"), and of it Brocchi says, "it is a dark gray, and not reddish brown as in the specimens of M. Morelet. All of the upper surface of the body and tail is covered with an orange mantle, the surface of which has a few dark gray spots." Brocchi thus succinctly summarizes the difference between this specimen and that figured above it on the same plate (figure 3).

Figure 1 of Brocchi's plate is listed on the legend as being from "Vera Cruz," and is similarly cited in his discussion of "Variété II," which almost certainly refers to the specimen illustrated as figure 1, since the discussion states that the specimen—unlike the others shown—has distinct orange maculations on its limbs, and the delineation in figure 1 clearly shows this. Figure 2 of the plate is described in Brocchi's text under "Variété III." The description given there fits the figure perfectly, even to the strongly annulated tail shown in the plate, and which Brocchi specifically mentions as "les annulations de la queue sont tres marquées (fig. 2)."

Figures 1, 2, and 4 of Brocchi's plate 18 bis are clearly *Bolitoglossa platydactyla*. Figure 3, although described in the plate legend as being from "Vera Cruz," is clearly associated through textual reference with one of those sent to Duméril, Bibron, and Duméril by Morelet from Dolores, Ptéen, Guatemala. Moreover, the specimen described by Brocchi as the first of the two sent by Morelet, and which we believe is

[1] Received June 4, 1948.

depicted in figure 3 of Brocchi's plate, is described by the original authors in much the same terms: " . . . in the other, these spots are united to form two black bands on the trunk, and between these bands there are distributed many spots of the same color." Brocchi of course described three orange bands, while Duméril, Bibron, and Duméril described the dark ground color between the orange bands. In either case, the general effect is the same, namely alternating bands of orange and black.

So far as Brocchi is concerned, then, the conclusion that he validly restricted the name *mexicana* to the Petén species is not reasonably contestable. Even if the word "type" in the plate explanation is construed to mean only "typical" instead of "*the* type"—as indeed is implied by various facts, including citation of the other figures as "variété"—the restriction of the name to at least the *series* from Petén is unequivocal.

Smith's conclusion, on the basis stated, that *mexicana* is a synonym of *platydactyla* is therefore incorrect. On the evidence given it is a valid name for the Petén species and *moreleti* (Smith, 1945) is a later synonym.

If Brocchi's action were the only one to be considered the nomenclature of these species would be clearly evident. Unfortunately, two other factors throw doubt upon the permanence of any conclusion now reached.

First, Duméril et al. (1854, p. 94), after discussing the "Caractéres" of *B. mexicana*, cite the following: "SYNONYMIE. 1838. Oedipus platydactylus? Tschudi, Class. Batrach. p. 93, no. 7." Had the question mark not been included, there is little doubt that this citation could automatically place *mexicana* in the synonymy of *platydactyla*. The question mark actually, however, introduces a situation for which there is no policy recommended by either the Opinions or Rules of the International Commission on Zoological Nomenclature. Moreover the identity of *Oedipus platydactylus* Tschudi is not absolutely clear, inasmuch as he cites a *nomen nudum* (*Salamandra platydactyla* Cuvier) for the source of the specific name, although the genus *Oedipus* (monotypic) was new. One realizes that the reference is to Gray's work (Reptilia, in Griffith's Cuvier's Animal Kingdom, 1831, p. 107), in which "*Salamandra platydactyla* Cuvier" is very briefly described. In reality Cuvier never described the species; Gray was, apparently, accepting the names on certain museum labels of Cuvier. So far as Cuvier is concerned, the name may be considered a *nomen nudum*, although most authors, even a recent monographer of the group (Dunn, Salam. Fam. Plethodontidae, 1926, p. 400) have accepted Cuvier as the author of the name. The point is perhaps academic, but as long as it remains a debatable point the proper allocation of the name *mexicana* remains in doubt.

A second complicating factor is the action of Boulenger in 1882 (Cat. Batr. Grad. Caud. Batr. Apoda Brit. Mus., ed. 2), one year prior to the publication of Brocchi's work. In the synonymy of *Spelerpes bellii* Gray 1850 (p. 68) he cites the following: "*Bolitoglossa mexicana* Dum. & Bibr., p. 93, pl. 104, f. 2." The allocation is correct; certain specimens, including the one whose figure was cited, did belong to *Spelerpes bellii* Gray [=*Pseudoeurycea bellii* (Gray) as of today]. But on page 73 he cites the following in the synonymy of *Spelerpes variegata* Gray [=*Bolitoglossa platydactyla* Gray]: "*Bolitoglossa mexicana*, part., Dum. & Bibr., pl. 104. fig. 1." Actually the figure cited does not belong to *platydactyla*, but to the Petén species. Not until 1936, however, was it realized that the Petén species was different from *platydactyla*; even a recent monographer (Dunn, Salam. Fam. Plethodontidae, 1926, p. 400) was not aware of their distinctness. Whether Boulenger was correct at all, or correct even by the interpretation of his time, in allocation of the cotypes of *mexicana* other than those representing *bellii* is perhaps immaterial; the point is one, again, open for debate since no procedure is specified by taxonomic rules. This is certain: that as the species was then (1882 up to 1936) thought of, all the cotypes of *mexicana*, other than those of *bellii*, were correctly placed by Boulenger with *platydactyla*. The really important action by Boulenger, however, was the inclusion of the word "part" with reference to Duméril et al. under *variegata*, and omission of any qualification in the reference under *bellii*. Does this constitute a restriction of the name to the synonymy of *bellii* by Boulenger? It seems quite possible. Is Bou-

lenger's restriction, if admitted, superseded by Brocchi's?

Until these questions are settled, there is absolutely no certainty whatever of the proper name, under the Rules, for the Petén species. A request has been submitted, accordingly, to the International Commission for a ruling on each of the three chief principles involved on which a decision is necessary prior to definite establishment of the name.

CONCLUSIONS

1. The name *Bolitoglossa mexicana* Duméril, Bibron, and Duméril is not a synonym of *B. platydactyla* because of any action by Brocchi.

2. Said name may, however, possibly be regarded a synonym of *B. platydactyla* on the basis of inclusion of the latter name in the synonymy of *B. mexicana* by Duméril et al.

3. Said name may also, if No. 2 is not true, be regarded a synonym of *Pseudoeurycea bellii*, on the basis of the supposed restriction of that name by Boulenger.

4. Said name, finally, if neither No. 2 nor No. 3 is true, may be regarded as a valid name for the Petén species (of which *B. moreleti* would then be a synonym) on the basis of type designation by Brocchi.

Obituary

HARRY DIAMOND, chief of the Electronics Division of the National Bureau of Standards, died suddenly at his Washington home on June 21, 1948.

Mr. Diamond was born on February 12, 1900, and attended schools in and around Quincy and Boston, Mass. He received his bachelor of science degree from the Massachusetts Institute of Technology in 1922, where he served in the SATC during World War I, and took his master's degree in electrical engineering from Lehigh University in 1925.

After Mr. Diamond joined the staff of the National Bureau of Standards as a radio engineer in 1927, his brilliant scientific achievements led to rapid advancement. He was chief of the Bureau's Ordnance Development Division during the war, and later of the Electronics Division, which now includes the ordnance work. During the five years between graduation from M.I.T. and entry on the bureau staff, he was at first employed by various industrial concerns in the Boston area and later taught for four years at Lehigh University, where he organized the first radio course at the University.

His work at the National Bureau of Standards was diversified, including aviation radio, radio aids to meteorological observations, radio direction finding, electronic ordnance, and general electronics. One of the inventors of the radio proximity fuze (No. 2 secret weapon of World War II), Mr. Diamond was widely honored for his work. Among the acknowledgments he had received were the 1940 Award for Engineering Achievement of the Washington Academy of Sciences; the Naval Ordnance Development Award for Exceptional Service, 1945; and the War Department Certificate for Outstanding Service, 1945. He was a fellow of the Institute of Radio Engineers; a fellow of the American Institute of Electrical Engineers; a division member of the National Defense Research Committee; a panel member of the Joint Research and Development Board; a director of the American Ordnance Association; and a member of the Washington Academy of Sciences and Sigma Xi.

Mr. Diamond played a large part in the development of the Instrument Landing System (ILS) and participated in the first completely blind flight and landing of an aircraft in March 1933. His ILS is now operating at many airports, and wide adoption throughout the world is planned. Another development of world-wide importance in which he had a major role is the radiosonde, which automatically collects weather information from the upper atmosphere. This device was a vital element in weather forecasting during the past war.

Late in 1942 Mr. Diamond was asked to form a new division within the Bureau of Standards, primarily for research and development on electronic devices for Government and industry. It was this division that worked on the radio proximity fuze for bombs, rockets, and mortar shells. Other contributions of the division to the radio art include visual beacons for aircraft guidance, antenna systems, range-beacon course-alignment procedures, a simultaneous phone and range-beacon system, aircraft-engine ignition shielding, automatic weather stations, upper-air wind-velocity determination by radio, a method for measuring direction-finder polarization errors, and an electronic bomb director.